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PHARMACOLOGY

AND

THERAPEUTICS

WILCOX

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AND

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WILCOX

BY THE SAME AUTHOR

MATERIA MEDICA AND PHARMACY

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PHARMACOLOGY
AND
THERAPEUTICS

BY

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UNITED STATES PHARMACOPŒIA; ETC.

SEVENTH EDITION, REVISED
WITH INDEX OF SYMPTOMS AND DISEASES

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PREFACE TO SEVENTH EDITION.

In this revision every effort has been made toward condensation so far as is compatible with clearness. The many advances in the subjects here treated have necessitated the division of the work into two distinct parts, the first being devoted to Materia Medica and Pharmacy, and this, the second, to Pharmacology and Therapeutics. It is believed best that the substance first should be learned and then its uses. It is hoped that this natural separation of the subjects will be acceptable to the physician and the student. In this volume the classification employed is based on the particular physiological systems upon which the various agents principally act. There is a complete list of Pharmacopœial drugs and preparations, together with such unofficial remedies as experience has found to be useful, without special description, except as to dosage, and very elaborate accounts of their pharmacological action and therapeutics are given. In these descriptions the effort has been made to present the latest views of the highest authorities in these departments, and to render the book as practically useful as possible by full details regarding treatment. The course on Pharmacology and Therapeutics should include laboratory and clinical demonstrations in the use of remedial agents. The two works combined offer, it is believed, a very complete presentation, in logical order, of the whole subject of Materia Medica and Therapeutics.

For valuable assistance, in revision and in proof-reading, the author would acknowledge the esteemed services of Doctor P. Brynberg Porter.

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CONTENTS.

PAGE.
DEFINITIONS 1
MODES OF ADMINISTRATION OF DRUGS 2
DOSES (POSOLOGY) 5
PHARMACOLOGICAL AND THERAPEUTICAL ACTIONS 8
  Relation between Chemical Constitution and Physiological Action 9
  Theory of Ions 9
DIVISION I. DRUGS ACTING UPON ORGANISMS WHICH INFECT THE HUMAN BODY, OR UPON PROCESSES GOING ON OUTSIDE IT 13
  Antiseptics 13, 18
  Anthelmintics 16, 101
  Antiparasitics 17, 110
  Antiperiodics 18, 115
DIVISION II. DRUGS ACTING ON THE BLOOD 133
  Drugs Acting on the Plasma 133, 137
  Drugs Acting on the Red Corpuscles 135, 200
  Drugs Acting on the White Corpuscles 136
DIVISION III. DRUGS ACTING ON THE CARDIAC MECHANISM 226
  Drugs Acting upon the Heart Directly 227, 230
  Drugs Acting upon the Vagus Centre 229, 279
  Drugs Acting upon the Accelerating Centre 230, 295
DIVISION IV. DRUGS ACTING ON THE VESSELS 296
  Drugs Acting Locally on Vessels 297, 301
    Vaso-dilators 297, 301
    Vaso-constrictors 298, 357
    Emollients and Demulcents 300, 405
  Drugs which act on the Vaso-motor Centres 301
DIVISION V. DRUGS ACTING ON THE SKIN 438
  Diaphoretics 438, 440
  Anhidrotics 439
  Drugs Producing a Rash on the Skin 440
DIVISION VI. SUBSTANCES ACTING ON THE URINARY SYSTEM 452
  Drugs Increasing the Quantity of Urine Secreted (Diuretics) 452, 458
  Drugs Diminishing the Quantity of Urine Secreted 455

PAGE.

Drugs Rendering the Urine Acid 455
Drugs Rendering the Urine Alkaline 455
  Antilithitics 455
  Lithontriptics 456
Drugs Preventing the Urine from Decomposing 456, 478
Drugs Altering the Composition of the Urine 457
Drugs Acting on the Bladder and Urethra 458
DIVISION VII. DRUGS ACTING ON THE BODILY HEAT 490
Antipyretics 490, 493
Drugs which Cause a Rise of Temperature 492
DIVISION VIII. DRUGS ACTING ON THE RESPIRATION 500
Drugs Altering the Composition of the Air Inhaled 501
Drugs Acting on the Respiratory Centre 502, 506
Drugs Affecting the Bronchial Secretion 504, 513
Drugs Relaxing Spasm of the Muscular Coat of the Bronchial Tubes, or Antispasmodics 504, 530
Drugs Acting on the Vessels of the Bronchi 505
Expectorants 505
Drugs which in Man Sometimes Produce Cheyne-Stokes Breathing 506
DIVISION IX. DRUGS ACTING ON THE DIGESTIVE APPARATUS 533
Drugs Acting on the Teeth 533
Drugs Acting on the Salivary Glands 534
✓ Drugs Acting on the Stomach 536, 553
Drugs Acting on the Intestines 544, 592
Drugs Acting on the Liver 550
  Stomachics 553
  Gastric Sedatives 586
  Laxatives 592
  Simple Purgatives 597
  Drastic Purgatives 607
  Intestinal Antiseptics 623
DIVISION X. DRUGS ACTING ON THE NERVOUS AND MUSCULAR SYSTEMS 634
Drugs Acting on the Muscles 634
Drugs Acting on the Peripheral Endings of Motor Nerves 635, 646
Drugs Acting on the Peripheral Endings of Sensory Nerves. 636, 652
Drugs Acting on the Trunks of Nerves 637
Drugs Acting on the Spinal Cord 638, 665
Drugs Acting on the Brain 639, 691

PAGE.
Drugs Acting on the Eye 643
Drugs Acting on the Ear 646
Drugs Acting on the Sympathetic System 646
    Drugs Increasing the Irritability of the Anterior Cornua of the Spinal Cord 665
    Drugs which Depress the Activity of the Anterior Cornua of the Spinal Cord 675
    General Cerebral Stimulants 691
    General Cerebral Depressants 728
    General Anæsthetics 765
Division XI. Drugs Acting on the Organs of Generation 783
Aphrodisiacs 783, 785
Anaphrodisiacs 783
Ecbolics (Oxytocics) 784, 791
Emmenagogues 784, 801
Substances which Depress Uterine Action 784, 802
Drugs Acting on the Secretion of Milk 785
Division XII. Serums and Antitoxins 803
Division XIII. Organic Extracts 815
Division XIV. Drugs Acting on Metabolism 827
Alteratives 827
Tonics 827
Division XV. Drugs which Have no Marked Therapeutic Properties 846
Index 853

PHARMACOLOGY AND THERAPEUTICS

DEFINITIONS.

Therapeutics.—The application of remedial agents in the eatment of disease. It includes:

General Therapeutics.—The application of curative agents other than drugs and medicines. *E. g.*, diet, climate, baths, venesection.

Rational Therapeutics.—Therapeutics based upon Pharmaco-dynamics. *E. g.*, the use of digitalis for mitral disease.

Empirical Therapeutics.—Therapeutics based upon clinical experiences only. *E. g.*, the use of colchicum for gout.

With the exception of such incidental allusion to other agents as occasion may require, in this work will be considered only that part of Therapeutics which is concerned with drugs.

Pharmacology.—The study of Materia Medica and Thera-eutics, including the origin, history, properties and uses of rugs and medicines. It includes:

Pharmacognosy.—The study of the physical and chemical characters of drugs, and the art of identifying and selecting them in accordance with those characters.

Pharmaco-Dynamics.—The study of the action of remedial agents upon the organism of man or the lower animals in a state of health.

Therapeutics.—Although the correct definition of this term is as given above, yet it is, for want of a better one, often used as the name of the branch of study which deals with Therapeutics. **Therapo-Dynamics** has been used in the same sense, but is faulty. **Expe-**

rimental Therapeutics has been suggested, but is not comprehensive.

Toxicology.—The study of the nature, effects and detection of poisons, substances which, introduced into the body inopportunely or in excessive amounts, are capable of destroying life. Courses of study and treatises upon Toxicology are, for convenience, commonly made to include the subject of antidotes and treatment, although this is, strictly speaking, a part of Therapeutics.

Attention must be paid to the manner, quantity and form in which drugs are given before entering upon a description of their actions and uses.

MODES OF ADMINISTRATION OF DRUGS.

(*a*) **Into the blood-vessels** by injection.—This method, while frequently employed in experimental researches upon animals, is resorted to only under extraordinary circumstances in the human subject. It is most commonly used for infusion of what is known as normal saline solution (*see* Sodium Chloride) after profuse hæmorrhage and in various forms of toxæmia. Among the objections to intra-venous injection are the difficulty of finding the collapsed veins and the danger, in puncturing a vein, of wounding the opposite wall of the vessel. Again, phlebitis is very liable to result, and thrombosis or embolism may possibly be caused. As a rule, hypodermatoclysis (*see* below) is therefore preferable; but if the symptoms are very urgent, the tissues œdematous from dropsy, or the circulation too feeble to insure absorption, infusion should be practiced without hesitation. It is the most prompt method in cases of shock, and it has even been proposed, with a view to the prevention of shock, that the free use of intravascular hot saline infusion, injected while the patient is still under the anæsthetic, should be adopted as a matter of routine, after all severe operations. This, however, should not be practiced before the operation, unless under exceptional circumstances, for the increased arterial tension would be likely to cause increased hæmorrhage during operative procedures. Intra-arterial, as well as intra-venous, infusion is sometimes practiced.

(*b*) **Into the subcutaneous tissues** by hypodermatic injection.—A perfectly clean syringe, fitted with an aseptic hollow silver needle, should be used for the injection. A part of the body is selected (commonly the external surface of the fore-arm), where the skin is lax. The skin is raised between the thumb and forefinger of one hand, and with the other hand the needle is inserted under it for about an inch, care being taken to avoid muscles and veins. The syringe is slowly emptied, then withdrawn, and slight pressure is made for a moment over the puncture. The bulk of an injection, as a rule, should be about .30 c.c. (5 m.). In order that abscesses may not result, the fluid should be aseptic, non-irritating, and free from solid particles. If not freshly prepared, it is advisable that a little boric acid should be added to it. Much the most convenient and satisfactory plan is to keep the drugs for hypodermatic use in the form of soluble tablets, and to dissolve one in the required quantity of water at the time the injection is called for. The advantage of this method is that it secures a much more rapid absorption than when the drug is given by the mouth, and it is ordinarily employed when the promptest possible effects are desired.

Hypodermatoclysis. By the bedside is placed an aseptic jar containing sterilized warm normal salt saline solution, to which air gains access only by means of a glass tube filled with sterilized cotton. From the lower part of this vessel extends a tube fitted to a trocar, which should be made aseptic. The skin over the part chosen for the infusion (preferably the ilio-lumbar region—the space between the highest part of the crest of the ilium and the lower border of the ribs) having also been rendered aseptic, the trocar is thrust into the subcutaneous tissue, and the solution allowed to flow at a rate not exceeding 4 c.c. (1 fl. dr.) to each 500 gm. (1 pound) of body-weight in each fifteen minutes. The necessary pressure is obtained by the elevation of the container, and absorption of the fluid is aided by gentle massage. This procedure has been employed with advantage to replace the fluid lost from the body through hæmorrhage or through excessive purging, as in cholera; also to wash from the body various impurities circulating in the blood and lymph and to flush the kidneys. It has likewise proved of service in cases of surgical shock and of threatened death from anæsthetics. Hypodermatoclysis, however, is slower than other methods in shock, on account of the poor general circulation, and is also open to the objections that the introduction of a proper amount of fluid (1½ to 2 litres—3 to 4 pints) may require a number of punctures, which cause pain subsequently, and that such a bulk of fluid causes such tension of the tissues that at the temperature best adapted to prevent shock (48.8° C.—120° F.) sloughing may possibly result.

Enteroclysis is also employed in shock and allied conditions, and not infrequently in association with intravascular infusion. This consists of the irrigation of the intestine, commonly with a saline solution, and it is most satisfactorily practiced by means of a double-current tube. With a return-flow tube in use the fluid does not cool, since fresh hot fluid is continually entering to replace the cooler which passes out.

The method is of service in warding off shock, and has been resorted to for this purpose after surgical operations.

(*c*) **Into serous cavities** by injection.—This method is employed only to secure certain local effects in such cavities themselves, as to wash out antiseptically the pleura after it has been opened or to cause adhesive inflammation in the tunica vaginalis by the injection of irritants. It has been proposed to introduce hot saline infusion directly into the abdominal cavity by means of a hollow needle for the purpose of combating shock. Also when this cavity is opened, as in cœliotomy, it may be flushed with hot saline infusion for the same purpose.

(*d*) **Into mucous cavities.**—The most common way of administering drugs is naturally by the mouth, so that they may be absorbed from the mucous membrane of the stomach or intestine. Circumstances conducive to rapidity of absorption are an empty stomach and a ready solubility of the drug in the gastro-intestinal secretions. When it is intended that the drug shall act only in the intestine, pills, made purposely insoluble in the gastric fluids, are administered. It is probable that some drugs are excreted in the bile by the liver, and so never reach the general circulation. Care should be taken to prescribe drugs in as palatable a form as possible and so combined as not to cause irritation.

It is sometimes advisable to administer drugs by the rectum, **suppositories** being employed for solids, and **enemata** or **clysters** for liquids. The fact must not be lost sight of that they are not then so readily dissolved or absorbed as when given by the mouth.

Drugs are also used for local effects, as by the **urethra** or **vagina** (**injections, bougies, pessaries**), or by the **respiratory passages** (**inhalations, cigarettes, sprays** or **nebulæ** for **inhalations; insufflations** for blowing into the nose, throat and larynx; **pigmenta, gargarismata, trochisci,** for a local effect on the mouth and pharynx; **nasal douches** for the nose). Sprays are given by means of an atomizer. Sometimes volatile drugs, as ether, chloroform and amyl nitrite, are inhaled for their general effect.

(*e*) **By the skin.**—Certain drugs may be absorbed from the skin if mixed with some fatty substance, especially hydrous wool-fat. In this way mercury may be absorbed by being rubbed in. Some may also be absorbed from the skin when they are volatilized. In this way mercury is introduced into the system by fumigation. The chief purpose, however, for which drugs are applied to the skin is to secure their local effects, and for this they are employed in ointments, cerates, plasters, etc.

To the **eye** and **ear** they are applied in washes.

DOSES.

The study of doses is called **Posology**. In determining the dose the following points deserve attention:

1. **Age.**—The adult dose is that for a person between twenty and sixty years old, but for women the dose should be somewhat smaller than for men.

For **children** under twelve Cowling's rule—divide age at next birthday by twenty-four—is the simplest and is generally of sufficient exactness. It must be borne in mind, however, that in the case of certain drugs the dose may be relatively larger than for adults, while in that of others they must be relatively smaller. Thus, children bear iron, alcohol, arsenic, belladonna, hydrated chloral, rhubarb, and cod liver oil remarkably well, but can take only very small doses of opium and its preparations.

For persons above sixty the dose should be slightly diminished as the age advances.

2. **Weight.**—In pharmacological experiments upon animals, in which it is customary to express the dose as a proportion of the weight, it has been found that if the same amount of poison be distributed through the tissues of a large individual as of a small one, less is contained in any given organ of the former, and less effect is therefore observed. This no doubt holds true as regards man also; so that somewhat larger doses of drugs should be prescribed for very large persons than for those of ordinary stature, while in the case of persons of unusually small size the dose should be proportionately diminished.

3. **Habit.**—A person who takes a drug continuously usually becomes less and less susceptible to its influence. Thus, an opium *habitué* after a time finds it necessary to use enormous doses of the drug in order to secure the desired effect. With strychnine and some other similar drugs, however, the susceptibility increases, instead of diminishing, and among purgatives cascara sagrada appears to be an exception as regards habit.

4. **Idiosyncrasy.**—Many individual differences in the matter of susceptibility are met with. These idiosyncrasies, which have frequently been observed with almost all commonly used drugs, consist of extraordinary sensitiveness, or tolerance, or of entirely atypical actions.

5. **Time of Administration.**—Drugs must be given with careful attention to the time which they require to produce their appropriate effects. Thus, some hypnotics have to be administered several hours before it is desired that the patient should go to sleep for the night, while for others to act but little time is needed. In order to cause a morning evacuation of the bowels, slowly acting purgatives must be taken the evening before, but promptly acting ones simply before breakfast. Drugs which are readily decomposed by the cont m-

ach should be given when that viscus is empty, preferably a half hour before the meal time. Experience has shown that the body is generally more resistant in the morning than in the evening, especially in the case of narcotic drugs.

6. **Mode of Administration.**—Drugs being absorbed much more rapidly from the subcutaneous tissue than from the stomach and upper portion of the intestinal canal, smaller doses are required when they are administered hypodermatically than by the mouth. On the other hand, their absorption is slower from the rectum; therefore to produce the desired effect, the rectal dose must be larger.

7. **Mental Influences.**—The mental condition of the patient sometimes has more or less influence on the effectiveness of drugs. Thus, if his mind is particularly fixed on the action of a hypnotic, so that he feels convinced that he will sleep, quite a small dose may answer the purpose; but if, on the contrary, he is laboring under considerable mental excitement and feels that it is quite impossible for him to sleep, an unusually large dose may be required.

8. **Other Temporary Conditions.**—Various other temporary conditions may influence the activity of drugs. As the drug is diluted by the stomach contents, absorption takes place more slowly after a meal than when the stomach is empty, and any local irritant action is less marked. Irritation of the stomach or intestine may also modify the effects of drugs, and vomiting and diarrhœa naturally tend to diminish their activity by quickly removing them from the alimentary canal. During pregnancy drugs must be used with great care. Purgatives may induce pelvic congestion, and thus lead to abortion, while drugs causing a marked fall of blood-pressure may have the result of asphyxiation of the fœtus. Drugs acting directly upon the uterus are naturally to be avoided, and also those whose effects may be transmitted from the mother to the child and do injury to the latter. During lactation certain drugs are excreted in the milk, and these may either act on the child or render the milk distasteful to it. At the time of menstruation all very active drugs must either be given with great caution or temporarily intermitted, and as purgatives tend to increase the flow, they should generally be avoided.

9. **Temperature.**—The action of drugs often being in part chemical, the temperature may be a factor of some importance in determining their effects in the case of cold-blooded animals and excised structures, but as in man the temperature range is so limited, this element may be practically disregarded.

10. **Preparation of a Drug.**—As a rule, a smaller dose of a soluble preparation, as a tincture, will be required than of a solid preparation, as a pill, which may be only slowly dissolved before absorption can

occur, although in the latter case much depends upon the process of manufacture. Pills which have been manufactured for a long time may be entirely insoluble.

11. Rate of Excretion.—In order to produce a prompt effect, a smaller dose (other things being equal) will naturally be required of a drug that is excreted rapidly than of one the excretion of which is slow. It is also true that, in order to maintain a continuous effect from drugs which are rapidly excreted, the doses must be repeated at shorter intervals.

12. Cumulative Action.—It sometimes occurs that in a person who has been taking a drug for some time, without the manifestation of any untoward effects, symptoms of poisoning suddenly make their appearance, or, at all events, that small doses of certain drugs taken repeatedly for a considerable period eventually give rise to symptoms which are more marked than those caused by a single dose. Such a result is attributed to the cumulative action of the drug, causing an acquired susceptibility, in consequence of which a given dose will produce more pronounced effects than it did originally. This is the opposite of habituation, and it may be due to any one of the following causes: (*a*) Greater capacity for absorption than excretion, as in the case of lead and mercury. (*b*) Inconstant absorption, successive doses of the drug lying unabsorbed in the alimentary canal until such time as the conditions, in consequence of some alteration in the intestinal contents, may become favorable to absorption, when the whole amount is taken into the system at once. This is sometimes met with in the case of digitalis. (*c*) Summation of effects, the effect of the preceding dose not having disappeared when the succeeding dose is given. (*d*) Sudden arrest in the excretion of the drug. For instance, it is thought probable that in the case of digitalis the renal vessels become contracted when the quantity of the drug in the tissues has reached a certain amount, so that excretion can no longer take place. It has been suggested also that the organism is subject to what may be called an *education* to the effects of drugs, particularly in the case of certain ones acting upon the central nervous system. Under this hypothesis the fact that the susceptibility to strychnine increases with its administration would be explained by the central nervous system becoming educated to the stimulating actions and responding more readily to them. Cumulative action, it should be noted, may occur along with tolerance. Thus it is found that the tolerance of certain tissues for nicotine does not protect others from the effects of the abuse of tobacco.

13. Disease.—The action of drugs is liable to be greatly modified by disease. This is seen, for instance, in the case of antipyretics, which have little or no influence upon normal temperature, but have a pronounced effect in reducing pyrexia. The dose also must sometimes be changed very much on account of the conditions produced by disease. Thus, in peritonitis it is a matter of common observation that enormous doses of opium are borne perfectly well. The same is true also in many instances of hepatic, renal and other very severe forms of colic.

The tendency of modern therapeutics is towards smaller and more frequently repeated doses.

PHARMACOLOGICAL AND THERAPEUTICAL ACTIONS.

By the action of a drug is ordinarily meant its physiological action.

The primary action is that due to the unaltered drug. The emetic action of such drugs as zinc sulphate is an illustration of this.

The secondary action is that due to compounds formed from the drug in the body. Thus, genito-urinary disinfectants like cubeb and copaiba owe their effects in this regard to a combination with glycuronic acid, in which form they are excreted by the kidneys.

The local action is that produced at the point of application before the drug enters the circulation.

The direct action is that produced upon organs and tissues with which it comes into immediate contact.

The indirect or remote action is that produced as a secondary result of the direct effect. The paralysis of the heart caused by chloroform is a direct effect, while the fall of blood-pressure which results from this is an indirect effect of the drug.

The general or systemic action is the effect produced by the drug after absorption, and is due to its elective affinity for certain organs to which it is carried by the blood. Most active drugs have an elective affinity for special organs, as the heart or the central nervous system. Not only this, but they attack certain definite tissues. Among those which select the central nervous system, for example, some act primarily upon the cerebral cortex, some upon the medulla oblongata, and some upon the spinal cord. It is sometimes the case that a drug has the effect of altering different structures in directly opposite ways. Atropine depresses the peripheral terminations of the secretory nerves, but stimulates the brain, while curara paralyzes the peripheral motor nerve endings, but stimulates the spinal cord. Different drugs show great differences in the extent of the field of their activity, and with most poisons the scope of this depends largely on the quantity administered. Hence, one which in small doses affects the medulla oblongata only, in larger doses may extend its influence to the brain and spinal cord, and when given in still larger amount act also on the heart and other organs. It is to be noted that the local effects of a drug may be entirely different in character from its general action; so that while it acts as an irritant at the point of application, it may be a depressant to the brain when it is carried thence in the circulation. For the reason that they are not absorbed or are absorbed in inactive forms, some drugs have only a local action. Others, again, have only a local action because they are excreted or deposited with such rapidity that there is not a sufficient quantity in the blood at any one time to produce any general effects. Many powerful poisons, on the other hand, show only an elective affinity for some internal organ to which they are conveyed in the circulation, and have little or no local action.

Relation between Chemical Constitution and Physiological Action.—While it is true that in a general way drugs closely resembling each other as to their chemical composition and properties produce similar effects upon the organism, as seen, for instance, in the case of the heavy metals, yet it is found that when their physiological action is carefully followed out, considerable differences in their effects are discovered. This is due to the circumstance that certain factors are met with which are apparently quite independent of their chemical constitution, or, at all events, which it is impossible to deduce from the latter. It is worthy of attention that the position of the radicals in the molecule is sometimes of great physiological importance. Thus, resorcinol (metadihydroxy-benzene) has a very sweet taste, while pyrocatechin (orthodihydroxy-benzene) is bitter. Moreover, substitution of one radical for another in organic compounds often greatly modifies the action. It can be stated, then, that it may be inferred with some probability that any substance belonging to a chemical group of similar constitution will give rise to symptoms resembling in general character those of the other members of the group, provided that it does not contain some radical which renders it inactive or gives it a more powerful action in some other direction. At the same time, the details of its action can be determined only by actual experiment. It is also equally true that the details of the chemical behavior of such substance can be ascertained only by performing the necessary reactions, and the point has therefore been well taken that for many drugs of definite chemical formula, while there is little prospect at the present time of explaining the latter from its constitution, there is still hope that much advance will be made in the near future in formulating the laws governing the details of its pharmacological effects.

The Theory of Ions.—It remains to speak in this connection of the theory of electrolytic dissociation and the underlying doctrine of the **ions**, which, there is every reason to believe, will, by opening up new methods of investigation, prove of the utmost importance in elucidating certain aspects of physiological action and affording a rational explanation of many obscure therapeutic facts. Furthermore, it gives promise of varied therapeutic possibilities in the future. According to this theory, when acids, bases and salts which, since they conduct the electric current, are termed electrolytes, are dissolved, either all or a part of the molecules are split up by the solvent into simpler substances, the electrically charged atoms or groups of atoms known as **ions.** In other words, ions are those constituent parts of the molecules which, under the directive influence of an electric current, travel in opposite directions through the solution. Those which take on a positive charge are called **kations,** and those assuming a negative charge, **anions.** A simple illustration is afforded in the case of hydrochloric acid, a solution of which is made up not only of HCl molecules, but also of H ions and Cl ions. When such a solution is completely dissociated, it would be put down as H + and Cl —. It is a fact, however, that while in a solution of hydrochloric acid there are dissociated chlorine ions, it does not contain free chlorine in the condition met with in a solution of chlorine gas. In solutions of a chloride the existence of chlorine cannot be demonstrated by its physical properties, but its presence can always be recognized by its reactions. The circumstance that all chlorides, by reason of their chlorine, yield a certain set of reactions which are precisely the same, whatever the associated element may be, is regarded as one of the strongest proofs of the correctness of the dissociation theory. Since all chlorides thus give off free chlorine-ions on solution, notwithstanding that each one in its solid condition is characterized by its own special properties, it becomes clear why they present a common set of reactions. The importance is insisted upon of the fact that only those portions of the substance which are ionized are chemically active, the ionized condition being necessary for the rapid reactions which electrolytes display. With the exception of hydrogen dioxide, water, the universal solvent of the body, seems to cause the best dissociation of molecules into ions. Formic acid comes next in this regard, then nitric acid; methyl alcohol is superior to ethyl alcohol, acetone and various ethereal salts follow, and the hydrocarbons are of only feeble power. It has been found by experiment that only those substances which afford abnormal osmotic pressure in solution are capable of conducting the electric current, and if they are dissolved in other solvents in which they behave normally, they lose this power. With our present knowledge concerning the mode of action of electrolytes, it is evident that the ions which conduct the current must always be present, *i. e.,* they are not formed by the current. The ions naturally act as molecules, and so increase the osmotic pressure. The ions which are formed from a substance, it has been shown, must necessarily be charged very heavily with electricity; otherwise they would not conduct the current. For example, in a solution of acetic acid there are undissociated molecules of $C_2O_2H_4$ and ions of $H+$ and $CH_3COO—$. Since the ions are charged with electricity, they do not behave as they would in the molecular state, *i. e.*, they are not given off as gases. Furthermore, it is a fact that some ions are always charged with positive electricity, while others are charged with negative; but no ion is known which is at one time positive and at another negative.

The physiological as well as the chemical effects of most of the electrolytes have been found to be entirely dependent upon their constituent ions, quite irrespective of the nature of their molecules. Thus, all acids are characterized by H ions, and it is in consequence of this that they all have certain general properties, while the differences between the solutions of different acids containing the same number of H ions depend upon the difference between their anions. The kation of acids is hydrogen; the anion of bases is the hydroxyl group (OH). The general conclusion to be arrived at is, then, that the physiological effects of an electrolyte are for the most part determined by the character of its ions. While the principal characteristics of most of the substances which are of importance in therapeutics are fairly well known, it is a desideratum to understand why or how it is that they produce their special effects, and so far as the electrolytes are concerned the theory of ions would seem to largely supply such knowledge. For instance, the long-recognized community of the reactions of the dissolved salts of a given metal (being the same with respect to that metal whether the chloride, sulphate, nitrate, or other salt is employed), received no adequate explanation until the promulgation of this theory. In the solid state, and when undissociated in solution, each salt has individual attributes; while in dilute solution, when dissociation is usually more or less complete, the properties of the salt are merely the sum of the properties of its ions. If, therefore, a series of salts contains a common ion, the properties of this will be common to all its members. As an illustration of this the behavior of iron salts has been cited. While all the simple salts exhibit common chemical reactions and have a very similar physiological action, compounds such as the ferrocyanides, for instance, neither yield the reactions of iron or exhibit the influence of the metal in their physiological effects. The explanation would seem to be that the simple salts yield metallic ions on dissociation, but the ferrocyanides yield the group ferrocyanogen, neither the chemical behavior or the physiological action of which is identical with that of iron itself. It is plain that when a dissociable body is administered, not one, but two separate agents are put in action in the tissues, so that the effect of each of the ions must be taken into consideration. In the great majority of such substances in the organic materia medica, however, the action of one ion is so much more powerful than the other that the less important one may be practically disregarded. This is especially true of the more toxic bodies. In the case of morphine sulphate, for instance, while this exists in the body as a morphine and a sulphate-ion, the action of the former ion is so much more powerful than the other that the sulphate-ion is of no consequence. Evidence of this is furnished by the fact that morphine hydrochloride, which in the body is dissociated into morphine and chlorine-ions, has practically the same action as morphine sulphate. With less poisonous substances, however, both the ions may exert a more or less powerful influence. Thus, we find that quite different symptoms are produced by potassium sulphate and potassium bromide, and this is because here larger amounts can be administered, and the SO_4 and Br ions are present in sufficient quantities to elicit their specific actions, which are quite as important as that of the K-ion. What are ordinarily called the strongest acids and the strongest bases are those which, in a given solution, are most ionized. The effects of an ion can be determined only by administering it along with another in the form of a salt, but certain ions, it has been pointed out, are so inactive in the tissues that, if any effect is noted after a compound of which they form part, the action can be ascribed with certainty to the other ion, unless the change arises from alteration of the physical properties of the fluids. Thus, the sodium ion and the chloride ion have been ascertained to be both practically inert, except in so far as they change the osmotic pressure; hence if a sodium salt or a chloride be found to cause some change which is not due to the physical alteration, the action is to be attributed to the other ion of the molecule. By **osmotic pressure** is meant the resistance offered by a non-permeating salt to the passage through a partially permeable membrane of the fluid in which it is dissolved; and this varies with the number of molecules and ions. (For additional remarks on the subject of osmosis *see* Sodium Chloride.)

Some further points deserve attention. Many observations point to the conclusion that the irritability of muscle and nerve depend upon the presence in them of compounds of proteid with the various ions, sodium, potassium and calcium, in definite proportion. Furthermore, it has been demonstrated by experiment that the physiological effects of certain drugs can be modified in definite ways by the addition of chosen radicals to the molecule. Thus, the convulsive action of strychnine, brucine and thebaine on the spinal cord is changed to a paralyzing effect by the introduction of methyl into the molecule. Again, the introduction of chlorine-ions into certain fatty molecules increases their narcotic and toxic properties. The results of these recent investigations would seem to afford ground for the opinion that in the forces of ionic attraction and repulsion is to be found the explanation of the rouleau formation of red blood-corpuscles, the agglutination of bacteria in appropriate media, and the obscure facts of chemotaxis, illustrated by the attraction or repulsion which certain chemical media have for some bacteria and for leucocytes. Protoplasmic movements doubtless take place by means of ions, the electricity-bearing portions breaking down when in solution, and it has been suggested that toxic and antitoxic effects may be due to various alterations in the composition of protoplasm forming living tissue. If a toxin which depends for its activity on a large number of monovalent anions can be controlled by a small number of bivalent anions, or even ions of much higher valence (thus requiring a smaller quantity), the question of remedy is apparent. So, among antiseptics, picric and salicylic acids may be destructive to low forms of life because they are easily dissociated in the tissue electrolytes and liberate large numbers of poisonous hydrogen kations. Mercuric bichloride and copper kations are for the same reason effective, but the solution of a mercury salt in strong alcohol (a substance in which no electrolytic dissociation occurs) has no germicidal properties. The neutralization of the toxic effects of phenol by concentrated alcohol is susceptible of a similar explanation. Under ordinary conditions, ions of high valence are markedly disinfectant; those of lower valence less so. As regards mercury salts, dissociation may be retarded by the introduction into an aqueous solution of either alcohol or of another salt dissociating the same anions. For example, calomel treated with increasing proportions of sodium chloride shows a steady decrease of toxicity, the cause of which is the progressive suppression of the formation of mercury ions. The dissociating power of a solvent is believed to be a function of all the physical or chemical properties of a substance, and not of any one of them. The results of a great number of experiments all tend to demonstrate the chemical inertness of molecules. As the reactions proceed, and the ions already present are used up, it is found that the molecules are gradually dissociated and furnish new ions, which then enter into the reaction. The chemistry of atoms and molecules has thus given place to the chemistry of ions.

The *classification of drugs* which is adopted here is one in accordance with the parts on which they principally act.

DIVISION I.—DRUGS ACTING UPON ORGANISMS WHICH INFECT THE HUMAN BODY, OR UPON PROCESSES GOING ON OUTSIDE IT.

A. Antiseptics are drugs which prevent the growth of micro-organisms, destroy or render innocuous the toxic products of their action upon the tissues of the body, or interfere with the absorption of such products. By some the use of the word antiseptic is limited to those substances which restrain the development of micro-organisms, while those which destroy the vitality of the latter are designated as germicides or disinfectants. The term disinfectant, by extension, is applied to those agents which kill non-pathogenic bacteria, as well as to those which destroy disease germs. Much discrepancy of statement is to be found regarding the fact of certain drugs being really antiseptics and as to the relative power of various antiseptics, owing to the circumstance that antiseptics act differently upon different organisms, while the difference between inhibiting the growth of micro-organisms and destroying their vitality has been lost sight of. There are also certain factors determining the efficiency of an antiseptic which ought to be taken into consideration. Among these are the following: The nature of the antiseptic agent, the strength in which it is used, the temperature at which it acts, the nature and number of the micro-organisms, the nature and quantity of the associated material, and the time of exposure. In testing the value of any antiseptic it is requisite that all instruments and substances employed in the procedure should first be exposed to a temperature sufficient to destroy any adventitious bacteria. A cultivating medium, such as agar-agar jelly, having been placed in two test-tubes, the substance to be tested, in suitable solution, is added to one of them; after which some fluid containing the micro-organisms selected is poured into both the tubes. Both are then plugged with sterilized cotton to prevent the entrance of germs from the air, and observation from time to time will show how far the development of the micro-organisms has been interfered with by the supposed antiseptic. As the potency of an antiseptic is dependent upon so many circumstances, it is impossible to determine with exactness the relative efficiency of various agents. In the following list some of the most powerful and generally used antiseptics are placed first.

1. **Heat** is the best antiseptic, but there must be a temperature of at least 100° C. (212° F.). Infected clothing, bedding, etc., may be heated in a dry-air chamber to between 93.5° and 149° C. (200° and

300° F.), but, on account of its superior penetrating qualities, steam, driven, under pressure, through the articles is decidedly preferable. Instead of this, the infected material may be boiled in water. Surgical instruments are generally disinfected in this way, but one per cent. of washing soda (sodium carbonate) should be added to the water to prevent their rusting.

2. **Corrosive Mercuric Chloride.**—A solution of 1 in 1000 is commonly used for disinfecting the hands and is sometimes employed in surgery and obstetrics. For most uses, however, one part to 3000 or 5000 of water, or even weaker, is the limit of safety. Gauze of the strength of 1 to 2000 will blister, if the skin is damp.

3. **Formaldehyde,** the official solution of which contains at least 37 per cent., by weight, has extraordinary power as a surface disinfectant, greater indeed than that of any known substance. It is especially useful for the disinfection of rooms and their contents when volatilized from a specially constructed lamp.

4. **Chlorine** for most purposes is too irritating, but the gas (which is generated by the action of hydrochloric acid on potassium chlorate or manganese dioxide) may be used to disinfect rooms. It is open to the objection that it attacks and bleaches many substances.

5. **Chlorinated Lime** is the best antiseptic for all excreta. 6. **Phenol,** or **Carbolic Acid,** is used but infrequently. If surgical instruments have been previously sterilized, the use of phenol indicates a distrust, on the part of the surgeon, of his assistants. 7. **Lysol** and various cresol compounds are powerful antiseptics and employed to a large extent.

8. **Bromine,** and, 9, **Iodine,** are rarely used, as they are too irritating.

10. **Iodoform** is used for dusting upon wounds, sores, etc., but is objectionable on account of its extremely disagreeable odor. It should be previously sterilized.

11. **Quinine,** and, 12, **Salicylic acid,** are too expensive for ordinary use.

13. **Boric acid** is used for many surgical purposes. Since in about a two and one-half per cent. solution it inhibits the growth of most bacilli, it may be employed to preserve solutions intended for hypodermatic use.

14. **Zinc chloride,** and, 15, **Potassium permanganate,** are much used for domestic purposes.

16. **Solution of Hydrogen dioxide** is the principal ingredient of various popular disinfectants.

17. **Sulphurous acid,** generated by the burning of sulphur, is used to disinfect rooms. It should always be associated with moisture. 18. **Charcoal** is not a disinfectant, but merely a deodorizer.

19. **Creosote, Zinc sulphate, Ferric oxide, Alcohol** and **Balsam of Tolu** are not much used.

As to **internal antisepsis,** the objection has often been raised that there are no known drugs which when swallowed or inhaled will with certainty destroy micro-organisms, either in the gastro-intestinal tract or respiratory passages, unless they are sufficiently concentrated to injure or prove fatal to the patient. By some authorities, however, it is claimed that calomel, naphthol and some other agents are capable of destroying certain varieties of micro-organisms in the stomach and intestines; and, whether this is the case or not, it is undoubtedly a fact (and one that is often lost sight of) that an infinitely small amount of a remedy which could not be administered in sufficient amounts to destroy, will often completely inhibit the growth of micro-organisms. Such drugs should therefore be classed as internal antiseptics.

Antizymotics are agents which arrest fermentation, and are sometimes divided into two groups, antiseptics and disinfectants. The fermentative processes may be caused by organized ferments, such as bacteria and the yeast-plant, or by unorganized ferments (enzymes), such as pepsin, diastase, ptyalin, etc.

Deodorants, or deodorizers, are substances which destroy foul smells. The volatile deodorants are mainly oxidizing and deoxiding substances which act chemically on the noxious effluvia, while the non-volatile deodorants are mainly absorbents, which condense and decompose them. Many antiseptics and disinfectants are also deodorants. Charcoal is often called a disinfectant, but is merely a deodorizer.

B. Anthelmintics are agents which kill (vermicides) or expel (vermifuges) parasitic worms infesting the alimentary canal. Three kinds only of such parasites are commonly met with in the temperate zone:

(1) Tape-worm (*Tænia solium* and *Tænia mediocanellata*). Anthelmintics: **Aspidium** (mostly used), **Oleum Terebinthinæ, Kamala, Cusso, Granatum, Pelletierine Tannate** (easily administered and very efficient), and **Pepo.**

(2) Round-worm (*Ascaris lumbricoides*). Anthelmintics: **Santonin, Chenopodium,** and **Spigelia** and **Senna.**

(3) Thread-worm (*Oxyuris vermicularis*). Anthelmintics: Rectal in-

jections of **salt water, infusion of quassia, solutions of iron salts,** or **diluted oil of turpentine** are commonly recommended. It is probable, however, that ordinary rectal injections are useless. Large soap and water enemata, the patient being in the knee-chest position, give the best results. Lime water is often very efficient. In the case of children it is advised that the lower bowel should be first emptied by an injection of warm soap and water. The child should then be placed upon a bed with its buttocks elevated, and the tube of the syringe be passed gently within the inner sphincter. The fluid (soap and water, lime water, or salt and water), previously warmed, must be injected with some little force, so that it may be lodged in the upper part of the rectum; otherwise expulsive efforts will be immediately excited. It is best that the enema should be given at bedtime in order that it may be retained for a sufficient length of time.

Anthelmintics for the tape or round-worm should be given when the alimentary tract is empty, to ensure their coming in contact with the parasite, and a purgative is therefore usually given a few hours before the anthelmintic. If the latter is itself not also a cathartic, another dose of purgative medicine should be administered after it, to bring away the worm or worms. When aspidium is employed castor oil should always be avoided, as its use is attended with considerable danger. In the case of tape-worm, in order to see whether the head is discharged, each stool should be received into a separate vessel, then mixed with water, and filtered through coarse muslin.

C. Antiparasitics or parasiticides are substances which destroy parasites. The term is usually applied to those which are destructive to the animal and vegetable parasites found upon the cutaneous surface. Of late the term parasitic has been extended to cover those found within the body as well.

(1) For the various forms of *tinea* the following are used: **Mercurial** preparations, especially the oleate, tincture of **iodine,** glycerite of **phenol,** an ointment of **pyrogallic acid,** a **boric acid** lotion, a **salicylic acid** lotion, **sulphurous acid, formaldehyde** and **thymol;** and if the patches are small, severe irritants, as **croton oil, cantharides,** and **chrysarobin** ointment. *Tinea versicolor* never requires severe irritants.

(2) As parasiticides for *itch,* **sulphur** ointment, **Balsam of Peru,** and **Styrax** are all effectual.

(3) **Pediculi vestimentorum** will be killed by any mild parasiticide.

Unguentum **Staphisagriæ**, unofficial: 1 part powdered seed, 2 parts each, olive oil and lard, is often used.

(4) **Pediculi capitis** and **pediculi pubis** are also easily killed by mild parasiticides; **mercurials** or Unguentum **Staphisagriæ** are employed.

(5) **Uncinariasis** (Ankylostomiasis). The hook-worm is readily killed by the administration of 1 to 2 gm. (15 to 30 gr.) of **thymol** every two hours, until four doses are taken. In very severe cases this treatment may be preceded by a few doses of **Betanaphthol.**

D. Antiperiodics are drugs which in diseases which recur periodically lessen the severity of the paroxysms or arrest their return. Some, and probably all, act as direct poisons to the micro-organism causing the disease.

They are **cinchona bark, quinine** and its salts (by far the most powerful), **quinidine, cinchonine, cinchonidine, arsenic trioxide, eucalyptus, hydrastis, salicin, salicylic acid,** and **berberine.** They are used for all forms of malarial fever and neuralgia.

All doses of *official* drugs and preparations are to be understood as the "average approximate (but neither a minimum nor a maximum) dose for adults."

A. ANTISEPTICS.

MERCURY.

1. **HYDRARGYRUM.**—Mercury. (Quicksilver.)

Preparations.

1. **Emplastrum Hydrargyri.**—Mercurial Plaster.

2. **Hydrargyrum Ammoniatum.**—Ammoniated Mercury. (White Precipitate. Mercuric Ammonio-Chloride.)

3. **Hydrargyrum cum Creta.**—Mercury with Chalk. (Gray Powder.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

4. **Massa Hydrargyri.**—Mass of Mercury. (Blue Mass.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

5. **Unguentum Hydrargyri.**—Mercurial Ointment.

6. **Unguentum Hydrargyri Ammoniati.**—Ointment of Ammoniated Mercury. (White Precipitate Ointment.)

7. **Unguentum Hydrargyri Dilutum.**—Blue Ointment.

2. **HYDRARGYRI CHLORIDUM CORROSIVUM.**—Corrosive

Mercuric Chloride. (Corrosive Sublimate. Mercury Bichloride.) **Dose, 0.003 gm. = 3 milligm. ($\frac{1}{20}$ gr.).**

3. **HYDRARGYRI CHLORIDUM MITE.**—Mild Mercurous Chloride. (Calomel.) **Dose** (laxative), **0.125 gm. = 125 milligm. (2 gr.);** (alterative), **0.065 gm. = 65 milligm. (1 gr.).**

Preparation.

Pilulæ Catharticæ Compositæ.—Compound Cathartic Pills. **Dose, 2 pills.**

Preparation.

4. **HYDRARGYRI IODIDUM FLAVUM.**—Yellow Mercurous Iodide. (Mercury Protiodide. Green Mercurous Iodide.) **Dose, 0.010 gm. = 10 milligm. ($\frac{1}{5}$ gr.).**

5. **HYDRARGYRI IODIDUM RUBRUM.**—Red Mercuric Iodide. (Mercury Biniodide.) **Dose, 0.003 gm. = 3 milligm. ($\frac{1}{20}$ gr.).**

Liquor Arseni et Hydrargyri Iodidi.—Solution of Arsenic and Mercuric Iodides. (Donovan's Solution.) **Dose, 0.1 c.c. (1½ ♏).**

6. **HYDRARGYRI OXIDUM FLAVUM.**—Yellow Mercuric Oxide.

Preparations.

1. **Unguentum Hydrargyri Oxidi Flavi.**—Ointment of Yellow Mercuric Oxide.
2. **Oleatum Hydrargyri.**—Oleate of Mercury.

7. **HYDRARGYRI OXIDUM RUBRUM.**—Red Mercuric Oxide. (Red Precipitate.)

Preparation.

Unguentum Hydrargyri Oxidi Rubri.—Ointment of Red Mercuric Oxide. (Red Precipitate Ointment.)

8. **LIQUOR HYDRARGYRI NITRATIS.**—Solution of Mercuric Nitrate.

9. **UNGUENTUM HYDRARGYRI NITRATIS.** — Ointment of Mercuric Nitrate. (Citrine Ointment.)

Unofficial Preparations.

Ammoniæ et Hydrargyri Chloridum. — Ammonio-Mercuric Chloride. (Sal Alembroth.)

Hydrargyri et Zinci Cyanidum.—Mercuro-Zinc Cyanide.

Hydrargyri Subsulphas Flavus.—Yellow Mercuric Subsulphate. (Turpeth Mineral.) **Dose, 0.12 to 0.24 gm.; 2 to 4 gr.,** as an emetic.

Hydrargyri Tannas.—Mercurous Tannate. **Dose, 0.06 to 0.12 gm.; 1 to 2 gr.**

Hydrargyrum Colloidale.—Colloidal Mercury. **Dose, 0.09 to 0.18 gm.; 1½ to 3 gr.**

Lotio Hydrargyri Flava.—Yellow Mercurial Lotion. (Yellow Wash.)

Lotio Hydrargyri Nigra.—Black Mercurial Lotion. (Black Wash.)

Mercurol.—Mercurol.

Pilulæ Antimonii Compositæ (U. S. P., 1890).—Compound Pills of Antimony. **Dose, 1 to 3 pills.**

ACTION OF MERCURY AND ITS SALTS.

External.—Locally the metal itself and many of its salts are inert. The action of others varies from that of a mild stimulant to the effect of a powerful irritant and escharotic. Thus, the acid solution of mercuric nitrate is strongly caustic. Mercury and its salts are readily **absorbed by the skin,** so that the physiological effects of the drug can all be produced by inunction. When metallic mercury, rubbed into fine globules, is applied to the integument in ointment, it passes into the gland ducts and along the roots of the hairs, and, after being oxidized, is dissolved and taken up into the tissues. It is also possible for the vapor to be absorbed by the mucous membrane of the lungs, and this **pulmonary absorption** of the drug is not at all uncommon when mercurial preparations (many of which are very volatile) are applied to the skin. Some of these preparations, when thus locally applied, have considerable efficiency in allaying itching, however produced, and a large number of them (among which may be mentioned the oleate, oxide, ammoniate and corrosive chloride) are **anti-parasitic,** destroying the animal and vegetable parasites which infest the skin. Mercury, it has been proved, is possessed of great **germicidal power.**

Lower Forms of Life.—Its germicidal potency is due to the fact that it is poisonous not only to the higher plants and animals, but also to lower organisms. Whenever it comes into intimate contact with albumins, it forms the albuminate and destroys life, and there can be no question that corrosive mercuric chloride and the other soluble salts of mercury are among the most important antiseptics at present known. It has been demonstrated that the bichloride in the strength of 1 to 50,000 destroys infusoria in about twenty minutes, and that even a solution of one part in one million destroys algæ in the course of a few days. While the bacteria are somewhat more resistant than these, it is claimed that a solution of 1 to 1,000,000 will delay the development of some of them, and the anthrax bacillus, it has been found, fails to grow in blood which contains 1 part in 8,000. At the same time, it is now regarded as indubitable that the germicidal power of the bichloride has been considerably over-estimated; for, while it has been commonly accepted that a strength of 1 to 1,000 is sufficient to completely disinfect fluids within a few hours, it has been proved that anthrax spores, after having been exposed to the action of a 1 per cent. solution for many hours, are still capable of developing as soon as the antiseptic is removed. Calomel, it has been demonstrated, has some effect as an intestinal antiseptic; but, owing to the difficulty of bringing them into intimate contact with the microbes, the insoluble salts are naturally much less efficient as germicides than the soluble ones.

Internal.—Mercury, unlike other metals, has, as is shown by its powerful germicidal influence, a strong specific action on protoplasm, and this property is due to its marked affinity for nitrogenous molecules. While its different salts have different external actions, yet after absorption their effects on the system are as a rule much the same. Both the local and general effects of a soluble salt, such as the bichloride, are more pronounced than those of one like calomel (which is entirely insoluble in water) since it comes into more intimate contact with the tissues, and so acts more energetically locally, while it is also absorbed more rapidly and in larger amount. When, however, a sufficient quantity of mercury in the form of calomel has been absorbed, the general effects are the same as if an equal amount had been taken up by the tissues as bichloride.

When mercury is absorbed, it has been shown that it circulates in the blood in the form of the albuminate, which is insoluble in water, but is rendered soluble by excess of proteid, and, also by such quantities of sodium chloride as are met with in the tissues. It has a marked **corrosive action**, which, as has been pointed out, is the more powerful because the precipitate formed with proteids is less insoluble in the surrounding fluids of the body, and is therefore more flocculent and affords less protection to the surface, than those formed by the other heavy metals; so that this destructive influence is not limited to the surface of a tissue, but extends into the deeper cells.

Absorption and Elimination.—When mercury is administered regularly for a considerable time, elimination, which appears to take place irregularly and intermittently, fails to keep pace with absorption. It disappears from the blood and is then deposited, in less soluble form, in the tissues and organs, and it has been found that this accumulation is especially liable to occur in certain parts of the body, like the kidneys, the intestinal walls, the liver, the spinal cord, and the medullary cavities of long bones. Absorption of the drug may take place from all surfaces, and is said to be especially rapid from serous ones. It is excreted principally by the bowels, but also to some extent in the urine, saliva, perspiration and milk. The excretion by the kidneys, which begins in about two hours after ingestion, has been noted as long as six months after the use of mercury has been discontinued. Mercury has been found in serum and in pus from ulcers.

Alimentary Tract.—The first evidences of mercurialism are met with in the mouth. The initiatory symptoms are usually a slight fetor of the breath, which is sooner or later accompanied by a disagreeable metallic taste, and tenderness of the teeth when they are forcibly brought together. These are followed by stomatitis, sponginess of the gums, swelling of the tongue, and **profuse salivation.** That this condition is not due to any local action of the mercury is shown by the fact that it results in exactly the same way when the drug is administered by inunction or by subcutaneous injection. The salivation is apparently due to the direct effect of the agent on the secretory apparatus, and sometimes it is the first symptom to make its appearance. If the administration be continued, the quantity of saliva poured out becomes enormous; it is altered in character, contains mercury, and irritates the skin over which it flows. The fetor is excessive and the gums are intensely inflamed, being marked by a dark red line at the junction of the teeth, and bleeding at the slightest touch. Both the parotid and submaxillary glands are enlarged and tender. The teeth become loosened in their sockets and may drop out, and excoriations caused by the irritation of the drug lead to the formation of ulcers, particularly where there are accumulations of microbes, as around carious teeth. Finally, the maxillary bones may undergo necrosis, as a result of the penetration of these ulcers, which sets up periostitis. Children under the age of three years are seldom salivated, but they are not exempt from the other effects of mercury on the system. In the stomach the action of the drug is less marked than in the mouth, but it may produce more or less hyperæmia, and in cases of poisoning this is accompanied by small hæmorrhages. In the small intestine also it has comparatively little effect, but in the cæcum and colon it gives rise to well-marked lesions. These consist of congestion and tumefaction of the mucous membrane, which later result in necrotic patches of considerable extent and ulcers about the folds; the appearances presented being practically identical with those met with in chronic dysentery. Perforation of the bowel may eventually occur. The intestinal inflammation is naturally accompanied by excessive purging and intense abdominal pain, with tenesmus. The stools, which are fluid in character and sometimes present a rice-water appearance, contain blood, mucus and shreds of mucous membrane. Small doses of the insoluble salts, however, usually cause loose passages without any griping or straining. They pass through the stomach undissolved, it is believed, but in the intestine, where time is afforded for the exercise of their affinity for epithelium, they become partially dissolved and produce the characteristic irritant effect of the drug. While a small proportion of such preparations is absorbed from the bowel, by far the greater part passes off unchanged in the fæces. It is possible, therefore, for very large doses of calomel to be taken without giving rise to any serious disturbance of the system. That salt, it has been found, exerts no action on the digestive ferments, but it has the effect of limiting the decomposition of food by retarding putrefaction in the intestine; its antiseptic action being aided by the removal of the decomposing mass in consequence of the increased peristalsis which it induces. After the use of calomel a diminution of the double sulphates in the urine is noted, and this is to be attributed as much to its cathartic as to its antiseptic qualities. When calomel is administered it is likely that a small portion will be changed into the corrosive chloride, thus enhancing its antiseptic effects. Further, it should be noted that the same transformation may take place after prolonged trituration with milk sugar.

Liver.—At the present time it is held that there is no sufficient evidence, either experimental or clinical, to show that, with the exception of the corrosive chloride, which increases the biliary secretion, the liver is in any way directly affected by mercurials. It was formerly universally believed that calomel and some of the other mercurial purges increase the secretion of bile, but this has been demonstrated, both in the case of man and of animals, to be a mistake. This opinion was apparently based on the spinach-green color of the stools after the administration of calomel, but the latter is now known to be due to the circumstance that the bile is prevented by this drug from decomposition in the intestine. Mercury, it has been shown, acts in the bowel even when the bile is suppressed, and the stools are often of a greenish color; which has been thought to be due to a metallic compound formed in the bowel, but which really results from bile pigment. Commonly this is decomposed by the microbes in the intestine, with the formation of the fæcal pigment, but mercury prevents, by its antiseptic properties, the growth of the microbes, and the bile therefore appears in the stools undecomposed and having its ordinary color. It is true that so-called "biliousness" is very frequently relieved by mercurials, but this is readily explained by the fact that the condition thus designated is one not dependent upon the liver, but a disorder of the alimentary tract. In this and other affections where the good effects of mercury were supposed to be due to its power to increase the flow of bile, equally satisfactory results may be obtained by the use of other remedies not regarded as cholagogues. At the same time, it is true, as mentioned, that the corrosive chloride does actually have some effect in increasing the amount of bile, and it may possibly be the case that occasionally when calomel is administered, some of it, owing to the presence of special conditions, is converted into that salt.

Kidneys.—Although it has recently been shown that mercury in the form of calomel has a decided diuretic action in rabbits, in other animals and in the normal human subject it generally has but a comparatively feeble influence on the kidneys. When dropsy due to cardiac disease is present, however, it has been found that a moderate dose of calomel induces marked diuresis. In the accumulations of fluid resulting from cirrhosis of the liver and from renal disease its action in this respect is much less constant, but in many instances is still quite pronounced. While the question has not as yet been definitely determined, it seems probable that, since calomel and other salts of mercury are known to have an **irritant effect** upon the kidneys, the diuresis produced by them is due to their direct action upon the renal epithelium. When small amounts of mercury are taken, the excretion of the drug by the kidneys has not been found to cause any pathological changes in the organs, but if the administration is continued for a considerable length of time, it gives rise to interstitial and glomerular nephritis; while large amounts induce parenchymatous nephritis with glycosuria. The relative quantity of mercury excreted by the kidneys is said to be increased by the inflammatory changes occasioned. In acute mercurial poisoning, when death does not result in a few hours, anuria is frequently observed. While the whole kidney is congested and the glomeruli are acutely inflamed, the most distinctive feature met with is a necrosis of the epithelium of the tubules in portions of the cortex; and the anuria is the result of these pathological changes. As in the case of certain other drugs, such as bismuth and aloin, there is sometimes a deposit of lime in the kidneys. In mercurial poisoning this is very generally noted in rabbits, but less frequently in dogs and in man. When it occurs, the tubules are found to be filled with a deposit of calcium phosphate, which is occasionally mixed with some chalk. It is thought most probable that this is thrown out in the necrosed cells and that, as these break up, it passes into the tubules. As a rule, the more marked the intestinal disturbance, the less pronounced are the destructive changes in the kidney in cases of poisoning, and it has been found that the latter changes are most frequently caused by the corrosive chloride.

Nervous System.—Mercury has comparatively little effect on the central nervous system. In acute poisoning the only symptoms observed are secondary to the fall of blood-pressure, while consciousness is preserved to the last. In chronic poisoning, however, there are not infrequently noticed tremor, erythism and hallucinations, which appear to be of central origin. Sometimes there is a dulling of the faculties. The general muscular weakness observed is believed to be due, not to any affection of the peripheral muscles and nerves, but to alterations in the centres. The paralysis which is sometimes seen in the limbs of workers in mercury has, on the other hand, been attributed to the action of the drug on the peripheral nerves, destroying the myeline sheath, and the areas of partial anæsthesia and the pains in the joints are also probably due to peripheral changes. When peripheral neuritis occurs, it takes place much later than in the case of lead poisoning. In man the muscles do not appear to be directly acted upon in either acute or chronic poisoning. Even when paralysis is developed, they maintain their irritability and do not undergo atrophy. In some instances, especially when the tremor is pronounced, the reflex excitability of the spinal cord is found to be exaggerated, but as a rule it remains unaffected.

Circulation and Respiration.—In some cases of acute poisoning patches of fatty degeneration have been found in the heart. For the most part, mercury has but little direct action on the circulation, and such changes as occur in the pulse are attributable to the shock and collapse in acute, and to the cachexia and malnutrition in chronic, poisoning. When general poisoning is caused by the intravenous injection of the drug, however, it is found that there occurs a very marked **fall of blood-pressure**, which is due to a direct paralyzing action on the heart (involving both ganglia and muscle) and on the blood-vessels. The respiration is affected only indirectly. The marked breathlessness which is sometimes observed in cases of chronic poisoning has been ascribed to the general muscular weakness.

The Blood and Nutrition.—In health the red corpuscles and the hæmoglobin appear to be at first augmented and afterwards diminished, and while the number of newly formed leucocytes has been found to be increased, this is more than counterbalanced by the decline in the older cells. In syphilis it has been noted that a pronounced decline in the amount of hæmoglobin is followed by an increase to beyond that present before the treatment was commenced, while there have been found fewer newly formed leucocytes, and more mature ones, after mercury. It would appear, therefore, that the blood reaction is different in health from that in syphilis, and that it varies in the successive stages of that disease. Whether mercury affects the nutrition in any way except through its action on the alimentary canal is not definitely known. It has been stated by some authors that the urea is increased by the use of small doses, but the investigation of these metabolic effects is very inconclusive and difficult, on account of the extensive action of mercury on the kidneys and intestine, and the prolonged administration of the drug is necessarily restricted to experiments on animals and on syphilitics. Very small doses may perhaps act in much the same manner, and have the same beneficial effect upon metabolism, as small doses of arsenic, the subject gaining in weight, etc. It seems to be fairly well established that in animals, at all events, the nutrition and weight are increased by minute doses of mercury given for some time, while large doses impair the former. Chronic mercurial poisoning affects metabolism profoundly, producing marked cachexia.

The Skin.—The excretion of mercury through the skin may produce various **cutaneous affections.** The most common eruption is a polymorphous erythema, more or less resembling that of scarlet fever. In other cases it is erysipelatous in character, with subcutaneous œdematous swelling, and still other forms are urticaria, roseola, pemphigus and purpura. Sometimes there is produced a very severe eczema, which eventually becomes pustular, and this is said to occur most frequently as the result of inunction. Usually the eruption is evanescent, being followed by desquamation in two or three days; but there has been observed a grave generalized dermatitis, with marked swelling of the face and extremities, excessive desquamation, subcutaneous infiltration, excoriation, fever, disturbance of the respiration, and prostration, resulting even in death.

Temperature.—Mercury in itself has no effect on the body temperature, but in severe ptyalism and in the more serious cutaneous affections caused by it there is always more or less febrile reaction. In collapse resulting from poisoning by the drug the temperature may fall several degrees below the normal.

THERAPEUTICS OF MERCURY AND ITS SALTS.

External. *Antiseptic Action.*—Mercurials, and especially the bichloride, are at the present time used very extensively for antiseptic purposes in surgery and midwifery. Of the numerous methods which have been proposed for disinfecting the hands, two, those of Welch and Fürbringer (which is much simpler), are considered trustworthy. They are described as follows: Welch's method: (1) The hands and nails are thoroughly cleansed with hot water and soap, the water to be as hot as can be borne, and the brush used to have been first sterilized with steam. This preliminary brushing should occupy from three to five minutes. (2) The hands are rinsed in clean, warm water. (3) They are next immersed for one or two minutes in a warm, saturated solution of potassium permanganate, and while in this solution they are thoroughly rubbed with a sterilized swab of absorbent cotton. (4) They are next placed in a warm, saturated solution of oxalic acid, and kept there until completely decolorized. (5) They are then thoroughly washed in clean, sterilized water or salt solution. (6) Finally, they are immersed for two minutes in 1 to 500 corrosive sublimate solution, rinsed in water, and dried. Fürbringer's method: (1) Remove all dirt under and around the nails. (2) Brush nails and skin of hands thoroughly with soap and hot water. (3) Immerse in alcohol, 95 per cent., for not less than a minute, and before this evaporates (4) plunge the hands in 1 to 500 corrosive sublimate or 3 per cent. carbolic acid solution, and thoroughly wash them for at least a minute; after which the hands may be rinsed in warm water and dried. On account of the difficulty of thoroughly disinfecting the hands, however, many surgeons have now adopted the practice of wearing rubber gloves when operating, and such gloves are also much used by obstetricians. For washing the walls or floors of infected rooms and furniture, linen and other articles, and for soaking towels, lint, sponges, etc., used in operations, a corrosive sublimate solution of the strength of 1 to 1,000 is usually employed. The corrosive chloride cannot be used for disinfecting metallic instruments, as mercury becomes deposited upon them. The use of this salt for vaginal injections and otherwise in obstetrics is believed to have been one of the principal factors in the remarkable reduction of the death-rate which has in recent years been noted in lying-in hospitals.

In preparing a surface of the body for operation the part is generally scrubbed with green soap and warm water, and, after being shaved, is cleansed with ether or alcohol. It is then irrigated with a 1 to 1,000 bichloride solution, but if the skin is at all broken a very much weaker one is employed. For a single washing of wounds or cavities the strength should not exceed 1 to 2,000, and weaker solutions are preferable. For continued irrigation it should not exceed 1 to 10,000, and even this strength has been known, when used in the peritoneal cavity, to give rise to toxic symptoms. Gauze washed in a weak bichloride solution is frequently used as a dressing after operations. In using the bichloride and other preparations of mercury as antiseptics it is often advisable to add about 5 parts of tartaric, citric or hydrochloric acid to 1 of the mercurial in the solution employed, in order to prevent its uniting with the albumin of the tissues. Otherwise an insoluble mercury albuminate may be formed, and the antiseptic value of the fluid be destroyed. Bichloride solutions should as a rule be freshly prepared, but if it is necessary for any reason to keep them for some length of time, either sodium chloride or a weak acid should be added to prevent decomposition of the bichloride. Bichloride tablets, tinted blue for safety, which are made of such a strength that one dissolved in a pint of water makes a solution of 1 to 500, are extremely convenient for ready use. Mercuric biniodide (1 to 4,000 to 1 to 20,000) has been used to a small extent as an antiseptic, and in eye surgery is said to be preferred by some to the bichloride, on account of its being less irritating than the latter. The mixed mercury and zinc cyanide, as suggested by Lister, is unirritating. It is said to have but slight germicidal value, but its inhibitory power is so great that a solution of 1 to 1,200 will permanently prevent putrefaction in animal fluids. Cyanide gauze may be made actively germicidal by impregnation with a solution of 1 to 4,000 of corrosive mercuric chloride. The following reaction may be used to determine whether the corrosive mercuric chloride with which gauze has been impregnated has partially changed into the mild chloride: If a black color appears upon application of lime water, calomel is present.

Irritant Action.—Unguentum Hydrargyri Iodidi Rubri (mercuric iodide, 2; benzoinated lard, 48), is employed as a dressing to indolent scrofulous and syphilitic ulcers. The acid solution of mercuric nitrate is of service in the treatment of warts, chancroids, syphilitic condylomata, mucous patches, and ulcers of the mouth, while citrine and red precipitate ointments, properly diluted, may often be applied with advantage to ulcers and sores, whether syphilitic or not, when a stimulating effect is desired. The application of solution of the nitrate is painful and may cause hæmorrhage, and it should be used with caution on account of the danger of giving rise to sloughing. It is recommended that it should never be employed for venereal ulcers in full strength, and as a substitute for its application Ricord's method of treatment may be adopted. This consists of washing the sores or condylomata with solution of chlorinated soda, and, after drying with absorbent cotton, dusting calomel, or equal parts of calomel and starch, over the surface. When a milder preparation is required, black wash (Lotio Hydrargyri Nigra,—Calomel, 1; glycerin, 8; mucilage of tragacanth, 20; lime water, to 160); is also very commonly used.

Antiparasitic Action.—Mercurial preparations are among our most valuable applications in external parasitic affections. For destroying lice upon the head white precipitate ointment, dilute citrine ointment, and corrosive sublimate, in the form of a wash, are all used, and the same agents, particularly the latter, are also efficient in such conditions as scabies, favus, ringworm, tinea sycosis, and pityriasis versicolor. The oleate of mercury is employed to some extent for the same purposes, but it should be considerably reduced in strength for most cases. The oleate diluted with oleic acid, with the addition of one-eighth part of ether, has been recommended by some. Unguentum Hydrargyri Oleatis (Oleate of mercury, 1; benzoinated lard, 3), may also be used. Caution should be exercised in not applying mercurials over too large an area, on account of the risk of toxic effects through absorption.

Cutaneous Affections.—A weak calomel ointment is often of service in itching affections, especially around the anus. In impetigo contagiosa and ecthyma an ointment containing 10 per cent. of calomel may be applied after separation of the crusts. Calomel ointments, as well as white precipitate ointment with the addition of a little menthol and cocaine, are also beneficial in herpes, herpes zoster, seborrhœa and eczema, especially of the genital organs. An ointment which is highly esteemed in many skin diseases is composed of equal parts of diluted mercuric nitrate, zinc oxide, and lead acetate ointments. For chronic psoriasis and eczema, especially of the hands and feet, an ointment composed of equal parts of mercuric nitrate ointment and lanolin, with a varying amount of oil of juniper, has been found efficient. Black wash and yellow wash (Lotio Hydrargyri Flava: corrosive mercuric chloride, 1; lime water, 240) may also be used to allay the itching of such cutaneous affections as pruritus senilis and urticaria, if the disease is not too extensive in area.

For the local treatment of variolous pustules and also of erysipelas it has been recommended that the surface should be sprayed with a solution containing 1 gm. (15 gr.), each, of corrosive mercuric chloride and either citric or tartaric acid, 5 c.c. (80 ♏) of 90 per cent. alcohol, and a sufficient quantity of ether to make 90 c.c. (3 fl. dr.). The following application has also been found highly successful in erysipelas: Resorcinol, 5; ichthyol, 5; mercurial ointment, 40; lanolin, 50. When the skin is not too tender, it is advised that the proportion of ichthyol should be increased. After the affected parts have been anointed with this they are covered with oiled silk or other impermeable material, and then enveloped in a light dressing and bandaged.

Diseases of the Eye and Ear.—In ophthalmic practice the ointment of yellow mercuric oxide, known as Pagenstecher's ointment, is largely employed. Calomel is also used as a sedative application in conjunctivitis and other affections. Before applying calomel to the eye, however, it should first be ascertained whether the patient has had a course of iodine treatment, since, if this is the case, a caustic compound may be formed between the mercury and iodine which may set up violent inflammation of the conjunctiva and the lids, possibly resulting in almost complete loss of vision. Largely diluted citrine ointment is sometimes used in the place of Pagenstecher's ointment in the treatment of chronic blepharitis, tinea tarsi, and eczema. Favorable results have been reported from the subconjunctival injection of a small quantity (0.12 c.c.—2 ♏) of 1 to 1000 solution of mercury bichloride in iritis (both syphilitic and non-syphilitic), choroido-iritis, exudative choroiditis, central choroido-retinitis, and detachment of the retina. Mercuric cyanide has sometimes been employed instead of the bichloride. This method of treatment has also proved successful in some cases of sympathetic ophthalmia, but appears to have failed in keratitis. It is stated to be not adapted to cases in which the stasis of the local circulation prevents, either wholly or in part, absorption of the injected fluid. In ear affections an ointment of yellow mercuric oxide, 0.32–0.65 gm. (5 to 10 gr.) to 30 gm. (1 oz.) of lard or cold cream, is used to a considerable extent to subdue inflammatory action.

Absorbent Action.—Oleate of mercury and the various mercurial ointments are used to a considerable extent to reduce swellings and promote the absorption of subcutaneous effusions and the general products of inflammatory action. They are not, however, superior in efficiency to other agents for such purposes, and have the disadvantage of introducing mercury into the system. While in some instances the constitutional effects of the latter may not be contra-indicated, in many others they may prove decidedly objectionable and even dangerous. The likelihood of the occurrence of such absorption and its possible consequences should always be borne in mind. Mercurial ointment, blue ointment, Scott's ointment (Unguentum Hydrargyri Compositum, which consists of mercurial ointment, 10; yellow wax, 6; olive oil, 6; and camphor 3), or the oleate in an ointment, may be applied in affections of the joints, orchitis and chronically enlarged glands. Chronic peritonitis has sometimes been treated with success by the use of a binder spread with one of these preparations or Linimentum Hydrargyri, which consists of equal parts of mercurial ointment, solution of ammonia, and camphor liniment. The ointment of red mercuric iodide, somewhat diluted and applied before a hot fire or in the direct sunlight, is said, in numerous instances, to have speedily reduced goitre and enlarged spleen.

Internal. *Alimentary Canal.*—One of the most important internal uses of mercury is as a purge, and the two preparations employed for this purpose are blue mass and calomel. In the condition commonly known as biliousness, which is characterized by lassitude, headache, constipation, nausea, yellowish-coated tongue, yellow conjunctivæ, and more or less "muddiness" of the skin, either of these drugs at night, followed by a hydragogue cathartic in the morning, will often completely relieve the symptoms, which are due, not to hepatic derangement, but to disorders resulting from the putrefactive changes in the gastro-intestinal tract which are responsible for the conversion of the green bile pigments into those of the fæces. The dark, greenish stools following the use of mercurials is explained by the abolition or lessening of these putrefactive changes. The principal action of the mercurials, it is believed, is exercised partly upon the glandular system of the gastro-intestinal tract, and partly upon the bacteria of the region, which, after being destroyed by the antiseptic properties of the mercurial, are swept away by the succeeding purge. Blue mass is less certain and less energetic in its action than calomel. In conditions where there are loss of appetite, tympanites, jaundice and whitish or clay-colored stools, and which are believed to be due to a catarrhal state of the mucous membrane of the hepatic duct and of the intestine, mercurials have long been highly esteemed on account of their supposed cholagogue action. It is true that they are generally efficient in removing the symptoms, but it is in the manner just referred to, and it has been found that such salines as sodium phosphate, magnesium sulphate and Rochelle salt will often answer equally well. In conditions like the above and in others where there is constipation, instead of giving a single full dose of blue pill or calomel, the practice has now become quite commonly adopted of prescribing the latter in small doses, such as .016 to .006 gm. (¼ to $\frac{1}{10}$ gr.), thoroughly triturated with sugar of milk and repeated every hour until a movement is secured. Some physicians stop the calomel after four or five doses have been taken, and give a dose of bitter water or Rochelle salt the next morning. Others give the calomel every fifteen minutes until six doses of .006 gm. ($\frac{1}{10}$ gr.) have been taken, and four hours afterward, a saline. The efficiency of the calomel is believed by many to be increased by combining with each dose .13 gm. (2 gr.) of sodium bicarbonate. The action of repeated small doses of calomel has been found to be entirely satisfactory, while this plan of administration is much more comfortable for the patient than the use of large doses. Mercurials are usually well borne by infants and children. Gray powder (Hydrargyrum cum Creta), in minute doses, has been advised for the sudden vomiting immediately after the ingestion of food sometimes observed in children. In cholera infantum and in other diarrhœal diseases, both acute and chronic, it may also often be used with good effect. In cases of diarrhœa due to the presence of some irritant in the intestinal tract, one or two doses will not infrequently prove curative by removing the offending material. Gray powder is a very useful purgative for children, and also for adults when a very mild effect is desired. Its action does not, as a rule, cause any griping, which is sometimes quite marked in the case of calomel. On account of their antiseptic effects in the intestine, mercurials are given to a considerable extent, especially in Germany, in typhoid fever. Some physicians make it a practice to commence their treatment of this disease with calomel. Calomel has also been recommended in Asiatic cholera, but it cannot be said that the results from it have proved very satisfactory. Formerly large doses at considerable intervals were often employed, but at the present time, when its use is resorted to here, it is more commonly given in small doses, frequently repeated, and also combined with opium, chalk, piperine, etc. It is stated, however, that large doses (1.30 to 4 gm.; 20 gr. to 1 dr.) sometimes appear to arrest vomiting when other means fail, though given in such amounts it is liable to produce ptyalism when reaction sets in.

Cardiac and Inflammatory Diseases.—In valvular disease of the heart with dropsy mercury sometimes proves of great service when combined with digitalis and squill, as in Guy's diuretic pill, which is composed as follows: Blue pill, powdered squill, and powdered digitalis, each, .06 gm. (1 gr.); extract of hyoscyamus, .10 gm. (gr. 1½). The drug is considered by many a very valuable antiphlogistic agent, provided that its use be restricted to the treatment of inflammatory action of a sthenic type. Some authorities believe it to be the best remedy in sthenic endocarditis, and useful also in myocarditis and pericarditis. While mercury bichloride is sometimes used instead of calomel in these affections, for the reason that it does not produce catharsis, it has not usually been found as efficacious as calomel. When the latter is given as an antiphlogistic, opium is commonly combined with it, not only to prevent its acting on the bowels, but also to relieve pain and irritation. In meningitis resulting from head injuries it has been recommended that a powder containing .015 gm. (¼ gr.) each of calomel and powdered opium should be given every hour for five or six hours, while at the same time an ice-bag is kept applied to the head. In the early stages of diphtheria and croup mercury is thought to exert distinct prophylactic power. It is generally given in the form of the bichloride, but some advocate, as preferable, the use of calomel, administered in small repeated doses in dry powders, believing that the good effect of the mercurial is at least in part due to its diffusion over the diseased surface, and the consequent antiseptic influence thus produced. In both pneumonia and pleurisy large doses of calomel have been highly recommended by certain clinicians, but the weight of opinion is to the effect that mercury is of decidedly less value in parenchymatous inflammations, such as pneumonia and hepatitis, than in those of a serous character, like pleurisy, pericarditis and peritonitis. It should be carefully borne in mind that it ought never to be given in asthenic inflammatory conditions, and that in employing it as an antiphlogistic it should be exhibited during the stage of exudation, and to facilitate the absorption of the newly organized lymph. In the treatment of iritis the use of mercury has proved especially successful, and it is the common practice in this affection to push the remedy to the point of ptyalism whenever the tendency towards the exudation of lymph is marked. Although the matter has never as yet been practically demonstrated, there is considerable ground for the belief that the drug has the effect of diminishing the fibrin in the blood, and as in inflammatory conditions the latter is known to be increased, it has been supposed that there is a certain antagonism between the processes of mercurialization and of inflammation. Before leaving this branch of the subject, however, the statement should be made that many modern authorities believe that mercury has little or no remedial influence in acute inflammation, either in the serous membranes or elsewhere, and that as it is commonly combined with opium, whatever benefit is noted from such treatment in inflammatory affections is to be attributed to that drug. In iritis, in which the efficacy of mercurials is admitted by all, it is contended that the good result is due to the fact that this disease is almost universally of syphilitic origin. With the growth of this opinion in the profession the antiphlogistic use of mercury has undoubtedly become much more restricted than formerly. The various forms of the drug are now very commonly administered in the shape of triturates, made with sugar of milk, which contain about 10 per cent. of the mercurial preparation. Thus minutely subdivided, the remedy is found to be more readily absorbed.

Syphilis.—Undoubtedly the most important of all the uses of mercury is in the treatment of syphilis. Whatever question there may be as to its special utility in other conditions, all are agreed as to its preëminent value in this disease. Like quinine in malarial fever, it is universally conceded to be a true specific, although its precise mode of action has not as yet been determined. While some authorities have contended that its curative influence is due simply to the general effects upon metabolism, it seems altogether probable that this is attributable to a specific toxicity for the syphilitic virus, which, when the drug is adequately exhibited, finally results in the complete destruction of the latter. Some eminent syphilographers hold that the action of mercury is to clear away from the tissues the products of a specific inflammation, or at least to relieve tissues encumbered with superfluous and obstructive material; but whether it develops a specific destructive action on the virus or not, the fact remains that mercury is employed in syphilis because experience has shown indisputably that it cures the disease. In order to secure the most satisfactory results it is requisite that its administration should be commenced at the earliest possible moment and that it should be continued for a considerable period after all manifestations of the disorder have disappeared. Its value in syphilitic condylomata, ulcerations, etc., has already been referred to, but here its local application is not sufficient, and an internal mercurial course should be entered upon just as soon as the diagnosis is established. This should never be discontinued under one year, and it is not infrequently necessary to maintain it, with periods of intermission, for several years.

While all are agreed as to the efficacy of the drug in the first and second stages of syphilis, authorities differ as to its value in the third stage. As a rule, however, in the tertiary period it will be found that the best results can be obtained by the mixed treatment, as it is called, mercurials in combination with the iodides, particularly potassium iodide. In most cases in which the disease is recognized early and in which mercurial treatment is promptly instituted and faithfully carried out, no tertiary symptoms occur and the use of the iodide is entirely uncalled for. The dose of the remedy should be carefully regulated in accordance with the circumstances of each individual case. The effort should be made, it is recommended, to give the largest amount that can be borne without the production of gastric, buccal, or other irritation; in other words, to overwhelm the disease without detriment to the general condition of the patient. In the earlier stages the proto-salts of mercury (and particularly mercurous iodide, known as the yellow iodide) are considered the most serviceable; later in the disease, especially when used in conjunction with potassium iodide, it is customary to employ the persalts, the bichloride and biniodide being the most esteemed. By some authorities the subcutaneous injection of mercurials is recommended, and under special circumstances these agents are introduced into the system in various other ways than by the mouth. Mercury is as efficient in congenital syphilis as in the acquired form.

Mercurol is a chemical combination of nucleinic acid and mercury, the former being obtained from yeast. It is sometimes employed in a 2 per cent. solution as an injection in gonorrhœa. This apparently destroys the gonococci, lessens the severity of the inflammation, and tends to prevent the development of complications. It does not entirely stop the discharge in some cases. It has also been used in the local treatment of other purulent conditions of a specific character, such as conjunctivitis, ophthalmia neonatorum, and otitis media, and also as an antiseptic dressing.

Sal Alembroth has useful antiseptic properties, and one of its advantages is that it does not combine so readily with albumin as corrosive mercuric chloride. For antiseptic purposes it is generally employed in the form of gauze (containing 1 per cent. of the sal alembroth) or wool (with 2 per cent.). Both are tinted with aniline blue, and as the latter is bleached by the discharge, it can readily be seen when it has soaked through. Sal alembroth, in doses of .02 gm. ($\frac{1}{3}$ gr.) to .60 c.c. (10 ♏) of water, is considered a convenient and non-irritating preparation for hypodermatic use in the treatment of syphilis. The precautions mentioned below (p. 42) should be observed.

Mercuro-Zinc Cyanide.—As an antiseptic, this has been claimed to possess the advantages of being non-volatile, unirritating, insoluble in water, and soluble only in three thousand parts of blood serum; so that it is not easily washed off from gauze by discharges from wounds. Its germicidal value, however, is stated to be very slight, though its inhibitory power is such that a one-twelve-hundredth solution will permanently prevent putrefaction in animal fluids. In order that mercuro-zinc cyanide gauze may be made actively germicidal it is recommended that it should be impregnated with a solution of one to four thousand of corrosive sublimate. The gauze and wool, as usually prepared, contain 3 per cent. of the salt each, and are both tinted pink. Mercuro-zinc cyanide has also been used in the form of an ointment.

Colloidal Mercury has been put forward as a reliable antisyphilitic, the advantages of which consist in the facility with which it is absorbed, the fact that it does not irritate the skin, its slow and enduring action, and its comparatively slight virulence. It is said to be effective also, when incorporated in ointments and plasters, for the treatment of epididymitis, arthritis, lymphadenitis, etc. Internally, in pill form, it has been recommended as a substitute for blue pill and mercurous iodide, as well as for corrosive mercuric chloride.

Modes of administration of mercurials.—(1) **By the mouth.**—A number of the preparations of mercury most commonly used for internal administration have already been spoken of. Among those not as yet mentioned is mercurous tannate, the dose of which is .06 to .12 gm. (1 to 2 gr.) given in a tablet triturate or pill. It is used to a considerable extent in the treatment of syphilis, and is well thought of by many. It is asserted that it passes unchanged through the stomach, but is rapidly absorbed in the small intestine, and that it does not irritate the alimentary canal. The Liquor Hydrargyri Perchloridi (corrosive mercuric chloride, 1; ammonium chloride, 1; water, 1000), is a favorite preparation, and is frequently combined with potassium iodide in tertiary syphilis. The usual dose is 4 to 8 c.c. (1 to 2 fl. dr.). When used with potassium iodide, there is formed mercuric iodide, which is kept in solution by the excess of the potassium iodide. Mercurous iodide should never be given at the same time as potassium iodide, as the latter immediately converts it into red mercuric iodide and metallic mercury. Gray powder, as has been mentioned, is much used in the intestinal disorders of children. It is also the most generally satisfactory preparation for internal administration in syphilis of early life. The ordinary dose is .03 to .06 gm. (½ to 1 gr.), which should be given frequently enough to bring the system under the influence of the drug without affecting the bowels. By some high authorities it is considered the best preparation for continued use in syphilitic adults, as well as children. For syphilitic ulcerations of the mouth a very good wash may be made of corrosive mercuric chloride, .24 gm. (4 gr.), in 300 c.c. (10 fl. oz.) of water, to which is added 4 c.c. (1 fl. dr.) of diluted hydrochloric acid and a little glycerin. In syphilitic ulceration of the tongue troches of liquorice, each containing .003 gm. $\frac{1}{20}$ gr.) of the bichloride, are sometimes employed. Allowed to dissolve in the mouth, they produce a constitutional as well as a local effect. Mercurials are not well borne by patients suffering from Bright's disease, in whom ptyalism is more readily induced than in others, nor in gouty or scrofulous subjects. In the latter, mercurialization may give rise to very serious results, and where there is a gouty tendency neuralgia is often caused by small doses.

(2) **By the rectum.**—By the use of suppositories patients can be brought very rapidly under the influence of the drug, and occasionally this method will be found of service. Each suppository may contain .30 gm. (5 gr.) of mercurial ointment.

(3) **Endermatically.**—Mercurials, externally applied, produce a general, as well as a local, effect, on account of their ready absorption. Reference has already been made to the use of various lotions in sores, ulcers and syphilitic condylomata, and the preparations in powder, particularly calomel, are often dusted on the surface in these conditions. Mercury is now never administered by the strict endermatic method, which consists of removing the cuticle by a blister or other means and applying the medicinal agent directly to the true skin, as it is a painful procedure and the systemic effects of the drug may be much more satisfactorily obtained in other ways.

(4) **By inunction.**—Mercury applied by inunction is quickly absorbed,

and this method has a well-recognized position in the treatment of syphilis. Among the other conditions in which it has been found of service is gonorrhœal arthritis. It is used to a considerable extent in the treatment of infants and young children affected with congenital or acquired syphilis, and also in the case of adults when it is desired to bring the system rapidly under the influence of the drug, and at the same time to avoid disturbance of the digestive apparatus. Either mercurial ointment or the oleate of mercury may be used for this purpose, and the latter possesses the advantage of not staining the clothing. It is customary to rub a piece about the size of a marble upon the inner side of the thigh or arm once or twice a day, and it is advised to change the application from place to place on account of the local irritation sometimes caused by the mercury. A hot bath previous to each inunction no doubt assists absorption. If the patient does not apply the mercurial himself, it is advisable that the person doing so, in order to avoid accidental salivation, should be protected by a bladder or a rubber glove, and should also wash his hands thoroughly with soap after each application. Another plan is to rub the ointment on the soles of the feet, so that the exercise of walking may promote absorption of the remedy. In the case of children it is often smeared upon the abdomen, after which the latter is covered with a flannel binder. It should be noted that in the eighth revision of the U. S. Pharmacopœia there has been introduced an Unguentum Hydrargyri Dilutum (mercurial ointment, 670; petrolatum, 330), with the name Blue Ointment, a designation which formerly was commonly applied to the official Unguentum Hydrargyri (mercurial ointment). At the present day it is not regarded as necessary that mercurials should be rubbed into the skin with friction, as it has been found that the mere fact of spreading them upon the surface of the body and leaving them in contact with the skin is sufficient to secure the physiological effects of the drug. It is asserted that in Paris syphilis has been successfully treated by the application over the spleen of a plaster composed of calomel, 20, castor oil, 6, and diachylon plaster, 60 parts; ptyalism being prevented by the alternate use and disuse of the plaster for periods of eight days at a time. Another method of external application is to paint the patient's back, after bathing, with a solution of gutta percha in chloroform, to which has been added a quarter of its weight of calomel. After the chloroform has evaporated the skin remains coated with a mercurial varnish. Calomel soap, made by triturating pure olive oil soap with calomel in the proportion of one to two or three, has been used by some as a substitute for mercurial ointment. It is cleanly and non-irritating to the skin, and its use is said to constitute an efficient method of mercurialization. A rare complication which has been attributed to the effect of mercury on the system is multiple neuritis, and it is said that this has especially been noted after the very free use of mercurial inunctions.

(5) **Hypodermatically.**—This method is now practiced to a considerable extent in special cases, and is a cleanly, rapid and efficient way of producing the constitutional effects of mercury without gastro-intestinal irritation. It is said to be more successful than any other in preventing relapses in syphilis. The corrosive chloride is usually selected for this purpose, and if properly employed seldom produces local irritation, although instances have been recorded in which it gave rise to abscesses and sloughing. Care should be taken that the syringe and needle are aseptic, and it is recommended that the needle should be deeply inserted, preferably into the muscles on the outer side of the gluteal region. If much pain is caused by the injections, a piece of ice may be held over the spot both before and after the insertion of the needle, or cocaine may be injected immediately before the mercurial. But one injection a day should be given, and it is advised that this should be at bedtime. A solution of .06 gm. (1 gr.) of corrosive chloride in 8 c.c. (2 fl. dr.) of distilled water may be employed, and of this .60 c.c. (10 m.) may be administered at first, and the dose gradually increased until 3 c.c. (50 m.) is reached, or until constitutional effects are observed. As soon as this is the case the dose should be reduced to the minimum. In some old cases of syphilis, in emaciated, broken-down subjects, it is recommended, instead of using daily injections in small doses, to give as much as .015 to .02 gm. (1/4 to 1/3 gr.) two or three times a week. A large number of mercurial preparations have been proposed for subcutaneous injection, but none of them appears to have any distinct advantage over corrosive sublimate; while most of them have been found considerably more dangerous. The subcutaneous employment of sal alembroth has already been referred to. Gray oil, which consists of mercury, lanolin and olive oil, is more or less used for subcutaneous injection, and by some is preferred to any other preparation for this purpose. Some clinicians have reported very favorable results from the use of hypodermatic injections in infantile syphilis, particularly, of corrosive sublimate and of gray oil. In using mercurials hypodermatically points of importance are to see that the part is well rubbed immediately after the injection, so as to dispel the local accumulation of fluid, and that injections are not given on successive days at spots near to each other. One of the evil effects which are liable to be produced by the continued and free administration of mercurials is nephritis, and it has been found that the safest method of mercurialization, so far as the kidneys are concerned, is by the hypodermatic employment of the corrosive chloride, while the most dangerous is prob-

ably the use of inunctions. Very deep intra-muscular injections are advocated by some authorities as not only painless, but productive of the best practical results. A Pravaz syringe-full of a preparation consisting of purified mercury, 20; lanolin, 5; vaselin, 35, is injected deep into the tissues of the back once in fifteen or twenty days.

(6) **Intravenous injection.**—This method has been recommended by some as having certain advantages, one of them being stated to be more rapid absorption and therapeutic effect than by any other. It possesses certain disadvantages also, and the opinion has been expressed by good authorities that it should not be preferably used in cases of syphilis easily amenable to ordinary treatment or in the early stages of the disease, though it is of special value in obstinate cases resisting other treatment; also in advanced cases of organic syphilis, or when immediate relief is urgently called for by reason of pain, encroachments on a vital part, or rapid destruction of tissue. Cases of cerebral syphilis which had proved unamenable to ordinary treatment have been reported in which this method was attended with excellent results. The injection, which was practiced daily, was usually made into the superficial veins in front of the elbow, and the dose of corrosive sublimate (the preparation employed) was gradually increased from .0004 gm. ($\frac{1}{162}$ gr.) to .0027 gm. ($\frac{1}{24}$ gr.). By some writers, however, intravenous injections are considered so dangerous as to render this method unjustifiable. Certainly neither intravenous nor hypodermatic injection should be resorted to in the ordinary routine treatment of syphilis.

(7) **Fumigation.**—Mercurial fumigations often prove highly serviceable in syphilis, and by some the most satisfactory method of treating the secondary eruptions upon the skin is believed to be by fumigation with calomel two or three times a week, accompanied by the administration of the iodides internally, with tonics whenever necessary, and proper attention to the general health. The method is as follows: The patient, having taken a warm bath to prepare the skin for absorption, sits upon a chair and is covered with a large blanket or rubber cloth (a mackintosh cloak serves very well for the purpose), which is gathered in closely about his neck and extends down to the floor all around. The mercurial preparation, say 1.20 gm. (20 gr.) of calomel, is placed in a porcelain or metallic dish, over a spirit lamp, underneath the chair. The most satisfactory apparatus is one in which the alcohol flame sublimes the calomel and boils water at the same time, and is made of sheet iron or tin plate. The centre, on which the mercurial is placed, is flattened, and around this is a circular depression, which is about one-third filled with water. The heat produced generally causes profuse sweating, and the mercury, after having become volatilized, is deposited upon the cutaneous surface. In about twenty minutes the lamp is extinguished,

the general cachexia be combated by the most nutritious food, and such tonic or other remedies as may be called for. In establishments where mercury is used in the arts the same prophylaxis as in the case of lead is recommended.

FORMALDEHYDE.

Formaldehydum.—Formaldehyde. (Not official.)

Preparation.

Liquor Formaldehydi.—Solution of Formaldehyde. (Formalin. Formol.)

ACTION OF FORMALDEHYDE.

Formaldehyde is regarded as equal in germicidal power to corrosive mercuric chloride, while, on account of its volatility, which enables it to diffuse much more rapidly, it can be used for purposes to which the latter is not adapted. At the same time, it is only slightly poisonous to the higher animals. When the vapor is inhaled, its most characteristic effect is marked irritation of the respiratory mucous membrane, causing bronchial catarrh and a prickling and burning sensation in the nose and throat. Even when present in the atmosphere in very minute amount it gives rise to violent irritation of the air-passages. It also excites increased secretion from the salivary and lachrymal glands. The powerful action of formaldehyde on microbes and on mucous membranes has been attributed to its combining with some amide group in the proteids. Egg albumin and serum to which formaldehyde solution has been added is not, it is stated, precipitated by heat and is less easily digested by ferments, while casein so treated is not coagulated by the rennet ferment. The urine of animals to which it is given, even in moderate quantities, is found to be incapable of putrefaction. Experimental research has shown that a 1 per cent. aqueous solution will destroy all pathogenic spores within an hour. The drug has also a very powerful influence on various forms of organic matter, one part in four thousand completely decolorizing wine, precipitating the extractive and coloring matters. The efficiency of hexamethylamine, now so much used as a genito-urinary antiseptic, is thought to be due to the liberation of formaldehyde from it. The penetrating power of the gas has been found to depend largely upon conditions of moisture, but under favorable circumstances is very considerable. When the watery solution is swallowed by animals its first effect is the production of nausea and vomiting. The blood-pressure is increased at first and the cardiac rhythm is retarded, as the result, it would appear, of stimulation, direct or indirect, of the medullary centres. As the poisoning progresses, narcosis and coma are produced, and in rabbits convulsions and opisthotonos. In dogs the respiration is very markedly quickened a considerable time before death. It has been shown that a portion at least of the formaldehyde which is absorbed passes through the tissues unchanged and is excreted in the urine, and it is thought not unlikely that the whole of it may do so. Some observers declare that it is a blood poison, causing alteration in the form of the cells and leading to the production of hæmatin, and accordingly believe it probable that this effect is the chief factor in the intoxication caused by it. The fact has been noted that when administered hypodermatically formaldehyde produces less severe symptoms than when taken by the mouth, and this would seem to indicate that the effects caused by it are largely the result of its local action. So far as known, no instance has occurred in which it has caused in the human subject symptoms other than those of local irritation. One has been reported in which a man took several ounces of formalin, by mistake, and recovered from its effects in three days, and another in which 30 c.c. (1 fl. oz.) was swallowed, and the patient recovered in a week. Externally applied, formaldehyde has the effect of hardening the skin.

THERAPEUTICS OF FORMALDEHYDE.

The great practical value of formaldehyde as an antiseptic, disinfectant, deodorizer and germicide is now universally acknowledged, and the literature on the subject has become very voluminous. In the report of a series of careful experiments made under the supervision of the Health Department of New York City the following were among the conclusions reached:

nose and pharynx may excite bronchitis and pulmonary congestion and hæmorrhage. It has been found that while one volume of chlorine vapor in one million parts of air causes a certain amount of irritation, ten volumes in the same quantity of air, if inhaled for some time, will induce such serious effects as severe bronchitis and hæmorrhage and inflammation of the lungs. Applied to the cutaneous surface, chlorine water produces heat and redness, and, if the gas is prevented from escaping, will give rise to vesication. The germicidal action of chlorine is very pronounced, and in the presence of moisture it is one of the most powerful of **disinfectants** and **deodorizers.**

Internal.—Chlorine has a marked affinity for hydrogen, and as a result of its combining with the hydrogen of water, nascent oxygen is set free and acts on the tissues. When taken internally, a certain portion is converted into hydrochloric acid, which afterwards becomes changed to chlorides during the process of absorption. A portion of it, however, it is thought, may form proteid compounds in the body. The claim that it is excreted in the free state in the urine is now held to be unfounded, but free chlorine may be recognized in the brain after death from its inhalation. It is poisonous chiefly by its local action. Except in small doses, chlorine water causes corrosive and intense inflammation of the mouth, throat and stomach, with the production of collapse. After fatal poisoning from the inhalation of the gas, however, the gastric mucous membrane is found to remain unaffected. Apart from its local action, chlorine is said to have a narcotic effect upon the brain, and this has been attributed to the action of the proteid compounds mentioned.

THERAPEUTICS OF CHLORINE.

External.—As a disinfectant chlorine has the disadvantage of injuring colored fabrics and wearing apparel. It may also cause inconvenient or even dangerous symptoms in persons using it, unless handled with great caution. It is regarded as inferior to sulphurous acid anhydride, and still more so to formaldehyde, not from its being weaker in action, but because it is more difficult to apply in sufficient quantity. The room to be disinfected by it should be hermetically sealed, after the removal or protection of all metals and of fabrics likely to be injured or bleached. The gas can be generated from common salt, 18; manganese dioxide, 15; and sulphuric acid, 45; in iced water, 21 parts by weight. As it is heavier than atmospheric air, the vessel should be placed on a high shelf, in order that the chlorine may be diffused throughout the room. For chlorine disinfection of rooms chlorinated lime, with the addition of acid in excess, is used by many. To disinfect hands, moistened chlorinated lime is spread over the hands, next a large crystal of washing soda is held in the hands, and they are washed, with rubbing, under water until a cooling sensation is experienced. The best disinfectant for excreta is fresh chlorinated lime, 1; dissolved in water, 16. 960 c.c. (one quart) is placed in the receptacle into which the dejecta are received, and left one hour. It may also be used with good effect in drains, sinks, closets, urinals, etc.

When exposed in the sick room, chlorinated lime acts rather as a deodorizer than as a disinfectant. The chlorinated preparations, in dilute solution, are very useful for destroying fetor in scarlet fever, diphtheria, aphthæ and gangrene, and also in gangrenous wounds, sloughing ulcers, foul discharges, etc. Chlorinated oil (olive oil saturated with chlorine) has been found a very efficient remedy in scabies. Chlorine water is sometimes used as an antiseptic in eye operations and diseases. A wash consisting of strong hydrochloric acid, .30 c.c. (5 ♏); potassium chlorate, .60 gm. (10 gr.); water, 30 c.c. (1 fl. oz.), which gives off free chlorine, is serviceable for syringing the nose and fauces in scarlet fever, and a combination of the tincture of ferric chloride with potassium chlorate, in which some free chlorine is also evolved, constitutes an excellent antiseptic gargle. A strong solution of chlorinated soda makes a useful application for the bites of snakes and insects, and in Australia chlorinated lime, freshly prepared, is used in solutions of varying strength by hypodermatic injection as an antidote to serpent venom; the remedy being inserted into several points about the wound.

Internal.—Chlorine water, in weak solution, is somewhat stimulant and tonic to the stomach. It has been successfully used, well diluted, in the diarrhœa of typhoid fever, particularly in markedly septic patients. After the administration of doses of 4 c.c. (1 fl. dr.) every hour the temperature falls, the intellect brightens, the tongue clears, and betterment goes on to recovery in many apparently hopeless cases. This remedy was formerly considered of service in chronic affections of the liver, but is seldom used now for the purpose of acting on this organ.

TOXICOLOGY.

In poisoning with chlorine taken by the mouth alkalies should be given to neutralize the acid formed, and albumin, in the form of eggs, etc., is also of service. Narcotics may be called for to allay pain. In poisoning by inhalation, steam may be inhaled to diminish the irritation. Ammonia gas may also be given for the purpose of forming ammonium chloride, but it should be remembered that the ammonia is itself irritant.

PHENOL.

1. **PHENOL.** (Carbolic Acid.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparation.

Unguentum Phenolis.—Ointment of Phenol.

2. **PHENOL LIQUEFACTUM.**—Liquefied Phenol. **Dose, 0.05 c.c. (1 ♏).**

Preparation.

Glyceritum Phenolis.—Glycerite of Phenol. **Dose, 0.3 c.c. (5 ♏).**

3. **CRESOL.**—Cresol. (Tricresol.) **Dose, 0.05 c.c. (1 ♏).**

Preparation.

Liquor Cresolis Compositus.—Compound Solution of Cresol.

ACTION OF PHENOL.

External.—Phenol is an **antizymotic** of considerable energy, and, while not so powerful as some other agents of this class, at times constitutes a useful antiseptic and disinfectant. In sufficient strength it is poisonous to all varieties of protoplasm, but, like other antiseptics, it is much less toxic to microbes than to the protozoa and other simple forms of life. Again, it affects some species of microbes much less powerfully than others, and it has been found that it takes as long as two days for the destruction of the spores of the anthrax bacilli by a five per cent. solution. It has also been found, however, that the development and reproduction of many micro-organisms is greatly interfered with, or altogether prevented, as long as they remain in a solution of one part of phenol to 400–600 of water. It seems to be well established, moreover, that one per cent. in an aqueous solution will destroy with certainty the virulence of ordinary septic and purulent matters, of the tubercle bacillus, and of the micrococcus of fowl-cholera. While some of the putrefaction germs are also destroyed by solutions of this strength, it is requisite that the action should be maintained for about two hours in order to insure this, and for the destruction of the infection of vaccine and of glanders a two per cent. solution is required. In oily or alcoholic solutions the antiseptic influence of phenol is extremely slight.

Phenol has the property of precipitating albumins and other proteids in solution, and also whenever it comes in contact with the tissues, and its action in this respect has been compared with that of alcohol, in which the proteid is precipitated, it is alleged, not because an insoluble compound is formed, but because of a change in the nature of the solvent. Hence it is argued that this agent must penetrate more thoroughly than the metallic antiseptics, which are rendered insoluble by the albumin they meet, and whose action therefore tends to remain confined to the surface. In sufficient concentration phenol exerts a mild **escharotic** action. When applied momentarily to the cutaneous surface it produces at first a burning sensation and a white discoloration, followed by a reddish stain, which gradually fades away as the skin desquamates. If the application be prolonged, a white opaque scar is formed, which afterwards becomes red and shining. When in the course of a few days it falls off, it leaves a light brown stain, which may persist for several weeks. If prevented from evaporating, the acid, by penetrating to the deeper tissues, may produce extensive **dry**

gangrene of the part. Phenol is a decided **local anæsthetic.** The application of a solution even as weak as five per cent. at first causes a sense of tingling and warmth, and this is followed by one of numbness, as an accompaniment of opacity and shrinking of the epidermis. If a strong solution is employed, the numbness amounts to almost complete anæsthesia. On the mucous membrane the acid has an escharotic effect which varies in degree according to the strength of the solution. Applied to wounds or abraded surfaces, a five per cent. solution causes pain and irritation and the formation of a pellicle from the precipitation of proteids.

Internal. *Gastro-intestinal Tract.*—When taken in concentrated form phenol causes burning pain, of short duration, and white eschars of the mouth, œsophagus and stomach (the mucous membrane appearing as if brushed over with a strong solution of silver nitrate and becoming hard and dry like leather), and, if death does not result at once, gives rise to violent gastro-enteritis, with its attendant vomiting and purging. The matters vomited have the characteristic odor of the drug. If taken in therapeutic doses, it produces a cooling and rather grateful sedative feeling in the stomach, and the bowels are unaffected by it.

Blood.—According to the observations of some, the number of red blood-corpuscles is reduced. In toxic doses it sometimes appears to have a disintegrating effect on these cells. In one instance of poisoning in man the presence of hæmoglobin in the urine indicated the destruction of some of the corpuscles, and occasionally such destruction has been noted as a result of the direct injection of carbolic acid into the blood-vessels of animals. While it gives rise to the slow formation of methæmoglobin when added to defibrinated blood, it has been found that this does not take place in the living animal.

Circulation.—It has been demonstrated that one of the characteristic effects of phenol, given in large doses, is the reduction of the arterial pressure, and this appears to be principally due to depression of the vaso-motor centre in the medulla oblongata. Weakness and slowness of the heart are observed, though at an earlier period there is cardiac acceleration, which is thought to result from the direct action of the drug on the muscle or on the regulating nerves.

Respiration.—The respiration, like the heart, is accelerated, and as this quickening occurs previous to the increased muscular movement caused by the drug, it has been attributed to action on the medullary centre, which is first stimulated and subsequently paralyzed; so that the breathing ultimately fails altogether.

Nervous System.—The most marked effects of phenol after its absorption into the blood are upon the central nervous system. In mammalian animals it causes, with or without a preliminary stage of depression, marked muscular tremor, which at intervals is interrupted by sudden twitches in different muscles, and later by clonic convulsions. The respiration and the heart, as mentioned, are at first accelerated, but afterwards become slow, irregular and weak. The movements grow progressively more feeble and appear at longer intervals, and the animal passes into a state of collapse, in which, however, the sensibility to pain is often preserved. Finally, death occurs from asphyxia. After very large doses the collapse may be immediate. No convulsions are observed, and the heart and respiration often cease simultaneously. In most cases there is an increased secretion of saliva, perspiration and tears, which is thought to be of central origin and possibly associated with the nausea and vomiting present. Frequently also the temperature falls far below the normal. In the frog a period of depression always precedes the increased movement. In man convulsions are comparatively rare, but delirium and excitement are sometimes seen. When the quantity of phenol taken is large, immediate unconsciousness may occur, and death result in a few minutes, but how far this is due to the extensive local corrosion and how far to direct action on the central nervous system is unknown. Increased irritability of the spinal cord appears to be the cause of the convulsions in the frog, which are similar to those seen after strychnine, and of the sudden contractions of the muscles in mammals, but the clonic convulsions and the presistent muscular tremor observed in the latter point to a cerebral origin. The infrequency of convulsions in man has not as yet been accounted for. The pupils, it may be noted, are almost invariably contracted in phenol poisoning; which is doubtless due to paralysis of the radiating fibres, the circular fibres being left unopposed.

Temperature.—Phenol, in sufficiently large doses, causes a reduction of temperature which, as in the case of the antipyretic group, is probably due to some alteration effected in the heat-regulating nervous mechanism, resulting also in an increase in the dissipation of heat. In cases of poisoning, however, the fall would seem to be very largely due to the collapse. While it undoubtedly possesses the power of reducing the temperature to some extent in fever, ordinary medicinal doses of carbolic acid have very little effect in this direction in the normal subject.

Urine.—It is a fact of considerable interest that the production of phenol occurs normally in the body, and that it is a constituent of the urine of man, as well as that of cattle, horses, dogs and probably other animals. It has been found to be constantly present also in normal human fæces, and it is considered probable that the acid is formed in the organism as a late product of the pancreatic digestion. Its elimination by the urine appears to be markedly affected by different diseases and conditions, being vastly increased in ileus, and diminished in anæmia, scurvy, tuberculosis and scrofula. One of the characteristic effects of the absorption of phenol is a peculiar **smokiness of the urine.** The discoloration varies in intensity in different cases. It is often a dusky green, which may change to dark brown or even black. It has been found that the acid passes through the tissues largely unoxidized, but a certain proportion of it is partially oxidized to pyrocatechin and hydroquinone, which combine in the body with sulphuric and glycuronic acid and are excreted in the urine as double (ethereal) sulphates and phenol, pyrocatechin and hydroquinone glycuronates. Pyrocatechin and hydroquinone are unstable bodies, and their oxidation products are doubtless the cause of the dark urine; pyrocatechin can only exist in alkaline urine, so that it cannot be the sole cause of the dark color. The presence in the urine of these results of phenol is recognized by certain reactions after distillation. The distillate gives a blue color with neutral ferric chloride, and a white crystalline precipitate of tribromophenol with bromine water, showing the presence of sulphocarbolic acid. The inorganic sulphates are usually absent. This is determined by the use of the barium chloride test, which does not precipitate the combined sulphates (sulphocarbolates), (Sonnenberg's test). The depth of the discoloration of the urine is said to depend on the quantity of dioxybenzols present, and not on that of phenol sulphate. Hence a darker shade is apt to be observed when the absorption of the drug has occurred from an open wound (which presents conditions especially favorable to oxidation) than from much larger amounts absorbed from the alimentary canal.

THERAPEUTICS OF PHENOL.

External.—Phenol was formerly employed in aqueous solution in the form of a spray, with the idea of rendering the surrounding air antiseptic, during surgical operations, but is no longer used in this way, and in the treatment of wounds in general it has been largely superseded by germicides recognized as more efficient. By some surgeons, however, it is still held in esteem; carbolic lotion (1 in 40) being used for the washing of wounds and carbolized gauze (bleached cotton gauze medicated with half its weight of a mixture of phenol, 1; resin, 4; paraffin, 4) as an antiseptic dressing. It is also employed to a considerable extent as a disinfectant for surgical instruments, soiled linen, and hospital apparatus, and as a disinfectant and deodorant for bed-pans, privies, drains, etc. For the latter purposes and on the walls and floors the crude acid is preferable, as its principal impurity, cresol (cresylic acid) is a very powerful disinfectant, and also because it is cheaper in cost. As a local application phenol constitutes one of the most highly esteemed remedies, and is employed in a great variety of conditions. It has sometimes been applied undiluted to wounds and burns, turning the tissues white and also exerting a hæmostatic influence. Afterwards the surfaces are cleansed with sterilized water. In carbuncle or malignant pustule, after incision and scraping, the undiluted acid acts as an antiseptic, and also relieves pain by its anæsthetic effect. Among the other conditions in which its application, undiluted, has proved efficient may be mentioned ulcers of the cervix uteri, chronic endo-cervicitis and endometritis, lupus, mucous patches, condylomata and cauliform excrescences. Even in scirrhus such applications, together with the daily injection of a five per cent. solution of the acid beneath the cancerous growth, has been thought to limit the extension and retard the progress of the disease. In performing minor surgical operations local anæsthesia may be secured either by brushing over the surface with the pure acid or by soaking the part, when this is practicable, for ten minutes in a 30 per cent. solution. A strong solution (such as 1 in 20) will alleviate itching from almost any cause, and on account of this anæsthetic action phenol has been called the "opium of the skin." Its anti-pruritic and parasiticidal qualities render it a useful remedy in a large number of cutaneous affections. In vesicular eczema, in erythema and in dermatitis, especially from poisonous substances, the following formula is strongly recommended; liquefied phenol, .36 c.c. (6 ♏); powdered zinc carbonate, 30 gm. (1 oz.); lime water and glycerin, āā 90 c.c. (3 fl. oz.). An ointment containing sulphur and camphor with phenol has been found most effective in many pruritic skin diseases, especially papular eczema, psoriasis, lichen and urticaria. The glycerite is a very serviceable form, and it may be used (generally diluted) with good results in such affections as prurigo, tinea versicolor, tinea tonsurans, and the other forms of tinea. It is also applied as a stimulant to indolent ulcers and to the patches of aphthous stomatitis; it is very efficient in allaying the itching of jaundice. It has likewise been used to prevent pitting from small-pox, and an ointment containing phenol and camphor has proved of service in alleviating the itching accompanying that disease. In the vulvitis or leucorrhœa of young girls, injections of the acid, in the strength of 5 parts to 1000 of water (pads of lint saturated with the same solution being used to separate the inflamed parts in the intervals) are said to be beneficial, and in the gonorrhœa of females a somewhat stronger solution, to which alcohol or cologne water is added. The strong acid is generally successful in relieving the pain of a carious tooth, but the pledget of cotton on which it is inserted into the cavity should be covered with dry cotton, in order to prevent its coming in contact with the gum and possibly causing sloughing. In ulcerated sore throat, tonsilitis, diphtheria and other throat affections a one per cent. solution in water and glycerin is useful as a gargle or wash for cleansing purposes, and also for the alleviation of pain, while a concentrated solution in glycerin is sometimes applied as a mild caustic. In "hay-fever," influenza and acute and chronic nasal catarrh, also, weak solutions are topically used to a large extent (frequently by means of the atomizer), and a favorite one is that of Dobell, which contains, in addition to carbolic acid, sodium borate and sodium bicarbonate, with glycerin. In acute coryza the combination of the fumes of phenol and iodine is often very beneficial. For this purpose a mixture of the acid and tincture of iodine, dropped upon a sponge placed in a wide-mouthed bottle, may be volatilized by wrapping the latter in a cloth wrung out of hot water, or even by the heat of the hand. The spray from a steam atomizer supplied with a 5 per cent. solution of the acid alone is also of service, and in acute conjunctivitis marked relief is afforded by holding the eye open in a spray of this kind. The use of the following formula has been very highly commended in the treatment of whooping-cough; Phenol, .36 gm. (6 gr.); menthol (4 per cent. solution), 15 c.c. (4 fl. dr.); cocaine hydrochloride (3 per cent. solution), 11 c.c. (3 fl. dr.); glycerin, 4 c.c. (1 fl. dr.); cherry-laurel water, 30 c.c. (1 fl. oz.). This mixture is to be inhaled every three hours, from an atomizer, the nozzle of which is inserted as far as possible into the mouth of the patient.

The deep-seated injection of phenol has been successfully practised in the treatment of lupus, ulcerations, poisoned wounds, erysipelas, secondary syphilitic abscesses, fistulæ, enlarged bursæ, synovitis, etc. In synovitis the injections are made into the affected joint. A solution of the strength of from 2 to 5 per cent. is commonly employed, but in the case of hydrocele the pure acid is sometimes injected into the sac, after the removal of the fluid. Piles are also efficiently treated with injections of carbolic acid, either pure or diluted with oil, but some accidents have been reported from the procedure. In the early stage of boils and carbuncles the formation of pus is said to be prevented by the use in this way of weak solutions, and gangrenous and necrotic anthrax has been reported to be cured by frequent injections of a 3 per cent. solution. It is recommended that the hypodermatic needle should be inserted obliquely to the centre of the inflamed tissue (the skin having been first anæsthetized by the application of the acid or by ether spray), and that it should not be connected with the syringe until it has been observed whether any blood escapes from it, which would indicate that it had entered a vein. It may also be mentioned that good results have been claimed from the parenchymatous injection of phenol in pleuro-pneumonia, septic puerperal fever, acute and subacute rheumatism, malarial fever, tetanus and other diseases.

Internal.—Phenol is a very useful remedy in gastro-intestinal irritation, especially in cases associated with or dependent upon fermentative changes from imperfect digestion, and also where the disturbance is characterized by a nervous element. Vomiting and flatulence, as well as gastrodynia, may often be relieved by it, and it is of great service in many cases of diarrhœa. For the latter condition it is very generally combined with bismuth subnitrate (.60 to 1.20 gm.; 10 to 20 gr.), and administered either in emulsion or in capsules. Phenol has been tried in a number of zymotic diseases, and while opinions differ as to its efficacy, considerable evidence has accumulated in its favor. In India, where the mortality from typhoid fever had previously been very great, admirable results in this disease were obtained from the use of a mixture containing phenol and spirit of chloroform. The pure acid has also been employed successfully, .16 gm. (2½ gr.) being administered at a time, in the form of a pill coated with keratin, in order to delay solution until after passing into the intestine. Another way of exhibiting the drug in typhoid which has won considerable favor is in conjunction with tincture of iodine, the two remedies sometimes being given in infusion of digitalis. The most remarkable results from phenol have been reported in the treatment of scarlet fever. In this plan of treatment the acid is given in doses of from .06 to .36 gm. (1 to 6 gr.), according to the age of the child, freely diluted, every two hours. The remedy is designedly pressed to the point of causing carboluria, and this condition is maintained until the fever is fully abated. So far from this proving injurious to the kidneys, it has been found that renal complication, which ordinarily occurs quite frequently in this disease, is exceedingly rare; while the cases thus treated prove in other respects very mild. It would seem, therefore, that the opinion which has prevailed in the profession, that when the urine begins to assume a smoky hue it should be regarded as a warning of danger, is an erroneous one. It is stated, furthermore, that the infection communicated by these carbolized patients is extraordinarily light, but yet sufficient to confer permanent immunity; so that it has been urged that it is better to let children take the disease in this modified form, rather than to leave them to the chance of contracting it later in its normal virulence. Where this was refused, however, it has been found that light carbolization of those exposed gives immunity for the time being. Strong evidence has also been educed of the value of large doses of phenol in the treatment of influenza, particularly in the later stages of the disease, which often prove so intractable. In tetanus it is claimed that as good results have been obtained from phenol as from the use of antitoxin. It is usually given hypodermatically in a two per cent. solution, from .30 to 1 gm. (5–15 gr.) being administered in the twenty-four hours. It is thought by some authorities that it neutralizes the tetanus poison in the same manner as the antitoxin. Its use is advocated on the ground that in addition to being an antidote to the toxin, it acts as an anæsthetic and general antiseptic. In erysipelas it has been given by the mouth and subcutaneously, as well as by deep-seated injection at the affected part. Large doses by hypodermatic injection have been recommended in bubonic plague, and cases of recovery have been reported. Phenol appears to have a distinctly curative effect in malarial fevers, and the combination of this acid with iodine in chronic malarial infection, as well as in the more acute cases after quinine has stopped the paroxysms, has been found of great value. In gangrene of the lung the internal administration of phenol combined with the use of a weak phenol solution by atomization is said to be very advantageous. In this condition, however, as well as in pulmonary tuberculosis, creosote is generally considered preferable at the present time.

Cresol has an action very similar to that of phenol, while its germicidal power is said to be nearly three times as great as that of the latter. It may be used internally and in surgery for the same purposes. It has been recommended, in a 1 to 1000 solution, as a solvent for atropine and other drugs employed in ophthalmic practice; it being claimed that such solutions are non-irritant and that they remain free from bacteria.

Lysol (unofficial) is an antiseptic containing 50 per cent. of cresols which, it is claimed, is only about one eighth as poisonous as phenol. In sufficient quantity, however, it may produce fall of temperature and general depression, with nephritis, and a few fatalities have been reported from its use. It is non-irritating, so that wounds may be absolutely disinfected by spraying with a 3 per cent. solution. Solutions of this strength, and even weaker ones, may produce a slight burning when applied to mucous membranes, but it is only transient. Lysol is used locally in from one-half to two per cent. aqueous solution. It has been considerably employed in gynæcological and ophthalmic work, and also in the treatment of lupus, pityriasis versicolor, and other skin diseases. Being readily soluble and a good antiseptic and deodorant, it is very serviceable for the disinfection of stools, sputa, privies, walls, floors, etc. It does not injure either metallic or rubber instruments, but it renders them slippery and difficult to grasp firmly. On celluloid articles it has a deleterious action. For cleansing the hands a one per cent. solution may be used, but it is said to be necessary that the water should be so hot as to be just short of boiling, which would make it somewhat painful when the hands are first introduced. The more recent official preparations of phenol have largely replaced this and various other similar substances in practice.

TOXICOLOGY.[*]

Phenol is employed for suicidal purposes far more frequently than any other poison, principally for the reason that it can be so readily obtained, and also, no doubt, because its lethal action, if the dose is sufficiently large, is so extremely prompt. Death has been known to occur within three minutes. In surgical practice the free use of the drug is not unattended with danger. Cases have been observed in which patients have passed, immediately after the application of carbolic dressings, into a condition of collapse similar to the shock following severe injuries or surgical operations. Of five such cases related by one author, recovery took place in only one instance. In other cases the poisoning occurs gradually and insidiously, and may be mistaken for septicæmia. The correct diagnosis can be determined by an examination of the urine. Cases have been reported in which, in addition to wounded surfaces, poisoning has occurred from absorption from the skin, the rectum, and the uterine and other cavities. The effects of the drug when taken by the mouth have already been described. Besides the local action of the acid, the warnings of danger have been pointed out to be sudden vertigo, contracted pupils, pallor of the face, enfeebled circulation, and embarrassed respiration. If the amount taken is sufficiently large, the patient rapidly passes into insensibility. The symptoms frequently resemble very closely those of apoplexy, but the odor of phenol may generally be detected in the breath and the characteristic corrosion produced by the acid be found to be present on an examination of the mouth. It is a fact deserving of note that in some instances where consciousness had been restored and the condition otherwise become markedly improved, the patient after a number of hours sank rather suddenly into fatal collapse.

Post-mortem.—If death has occurred quickly, the tissues and organs will smell distinctly of the drug. The mucous membrane of the mouth, pharynx, œsophagus and stomach, wherever acted upon by the poison, is found to be corrugated, tough and discolored. It is generally whitish, changing to a brownish color, and the corrosions may be surrounded by a zone of inflammatory redness. In some instances, where the pure liquid acid has been swallowed, the appearance is that of a broad chocolate-colored slough, extending continuously from the lips down into the stomach, and involving more or less of the gastric mucous membrane.

The blood is dark-colored, and generally coagulated in the heart and great venous trunks, although it has been maintained by some authorities that, in consequence of the alteration in its character caused by the drug, it coagulates with difficulty. While, however, the heart may be distended with loose clots, it is sometimes found empty and contracted. Acute fatty degeneration of the heart, as well as of the liver, kidneys and other organs, it is asserted, has been found in some cases.

Treatment.—Many of the cases of poisoning met with present very little hope of amelioration from whatever measures may be adopted. If the drug has been taken by the mouth, the stomach should be promptly evacuated by means of the stomach-pump or the hypodermatic administration of apomorphine hydrochloride, and demulcents, such as white of egg or thick soap-suds, given. Saccharated lime should be administered, in the hope that an insoluble combination may be formed in the stomach. Soap is also considered a chemical antidote. In view of the fact that in the tissues carbolic acid forms a comparatively harmless compound with sulphuric acid, the exhibition of sodium sulphate has been advocated by many authorities; but it is stated that practically this is of little or no benefit, either because the tissues are entirely paralyzed by the excess of carbolic acid, or more probably because the latter does not combine with sulphates as such in the body, but with organic sulphur compounds which are only in process of being oxidized to sulphuric acid. It is of the utmost importance to immediately give stimulants freely, such as ether or brandy subcutaneously. **Alcohol** should be given by the mouth, as pure alcohol is the most important antidote to phenol known. Success in this treatment demands that the acid and alcohol should be brought in contact; therefore if the acid has been swallowed for some time alcohol may not be efficacious. Atropine has also been recommended as an antidote, experiments on animals showing results which point strongly to the existence of the antagonism, and it is reported to have succeeded in some very unpromising cases. At all events, such stimulants to the central nervous system as atropine, camphor and caffeine are generally called for, and artificial respiration should be resorted to in all serious cases. Hot applications and friction should also be employed to combat collapse. Cider vinegar is stated to be one of the antidotes of phenol, having the effect when applied to a cutaneous or mucous surface which has been burnt by it of causing the prompt disappearance of the characteristic white eschar produced by the acid, and also of preventing subsequent scarring to a large extent. As it is supposed to be equally efficacious when the poison has been taken into the stomach, vinegar diluted with an equal quantity of water may be given if the patient is able to swallow. This article has the advantage of being always procurable without delay.

When practicable, the patient's bowels should be moved with sodium or magnesium sulphate, and it is advised that the soluble sulphates should be administered in small doses for several days, with the idea of facilitating the elimination of the phenol from the system.

THE PHENOLSULPHONATES.

1. **SODII PHENOLSULPHONAS.**—Sodium Phenolsulphonate. (Sodium Sulphocarbolate.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

2. **ZINCI PHENOLSULPHONAS.**—Zinc Phenolsulphonate. (Zinc Sulphocarbolate.) **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF SODIUM AND ZINC PHENOLSULPHONATES.

Sodium phenolsulphonate is less irritant and less poisonous than phenol, and while it is stated to possess less antiseptic power also, has considerable efficiency as a gastro-intestinal antiseptic and disinfectant. It does not cause smoky discoloration of the urine, and appears to be excreted in that fluid unchanged. The action of zinc phenolsulphonate is the same as that of the sodium salt and other phenolsulphonates, except that it is decidedly more astringent.

THERAPEUTICS OF SODIUM AND ZINC PHENOLSULPHONATES.

The phenolsulphonates were introduced for the purpose of securing, if possible, the antiseptic and antipyretic action of phenol without the caustic and depressing action of the drug. While sodium phenolsulphonate does not perhaps altogether maintain the position anticipated for it, it may in some instances be used with advantage as a substitute for phenol. It is employed as a topical application to inflamed and diseased mucous membranes, and internally as a remedy for fermentative dyspepsia. It has also been given in typhoid fever and other infectious diseases, such as septicæmia, puerperal fever, and the exanthemata, and successful cases have been reported from its use even in malignant endocarditis.

Zinc phenolsulphonate is employed as an astringent for indolent or foul ulcers, and in subacute inflammations of mucous membrane, in solutions which are somewhat stronger than those of zinc sulphate in use. It is thought by some that it may replace the sulphate as an astringent. Internally it has been used to some extent as an intestinal antiseptic, and has been recommended in typhoid fever as having the advantage, over the phenol-and-iodine treatment, of being less depressing to the heart and less injurious to the kidneys. Some good results have been reported from doses of .12 to .20 gm. (2 to 3 gr.) four or five times a day.

IODOFORM.

1. **IODOFORMUM.**—Iodoform. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Unguentum Iodoformi.—Iodoform Ointment.

2. **IODOLUM.**—Iodol. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Unofficial Preparations.

Losophanum.—Losophan. (Tri-iodo-meta-cresol.)

Acidum Di-iodosalicylicum.—Di-iodosalicylic Acid.

Action of Iodoform.

External.—Locally iodoform is capable of inducing analgesia of the rectum and the bladder, and when applied in considerable quantity to wounded surfaces also has considerable anæsthetic effect. In exceptional instances (for the most part confined to individuals with a predisposition to cutaneous affections) it gives rise to a certain amount of irritation, or efflorescence, and even to papular or eczematous eruptions, in the vicinity of such surfaces. On sound integument it ordinarily has no local action. Although it was formerly believed to be of very pronounced antiseptic value, it has since been demonstrated that this opinion was founded on a misapprehension; pathogenic microbes frequently developing as rapidly after having been exposed to its action as in the control cultures. When it was shown that iodoform itself has no germicidal properties, the theory was advanced that it only acts as an antiseptic after its decomposition, this resulting in the liberation of free iodine, which exerts an antiseptic influence. According to the best authorities, however, more recent investigations indicate that microbes found in wounds under iodoform treatment are not retarded or weakened in their development; proving, apparently, that the beneficial effects of such treatment are not due to any poisonous action on the germs. At present it is held that whatever benefits attend the use of iodoform dressings must be explained on the ground of a supposed action on the wounded surface, in consequence of which it secretes less fluid, and thus affords a less suitable medium for the growth of the germs. It is thought also that such growth may to some extent be retarded by the formation by the iodoform of a crust, which mechanically prevents microbes from penetrating to the wounded surface. The favorable results which have been observed from the application of iodoform to tuberculous ulcers of the larynx, tuberculous abscesses, and similar conditions are probably due to its beneficial effect on the granulation tissue, rather than to a specific action upon tuberculous disease, which many have regarded it as possessing.

Internal.—From moderate amounts of iodoform the most constant symptoms produced are headache, more or less nausea and vomiting, and an unpleasant taste and smell of the drug in the nose and mouth. When it is taken into the system in larger quantities there is experienced the same taste and odor, the headache is accompanied with giddiness, and the patient is restless, uncomfortable, and unable to sleep. The action of the heart is feeble and accelerated, the pulse sometimes reaching 180, and there is a rise of temperature to 104° F., or even higher. From the first there is anxiety and a general depression which increases as the case progresses. This deepens into true melancholia, with hallucinations, generally succeeded by violent delirium and mania, which may last for days or terminate in a shorter time in fatal collapse. In exceptional instances there is an entire absence of signs of cerebral excitement, and the patient sinks into a profound sleep, ending in coma and collapse. Of all the symptoms of iodoform intoxication, the most characteristic are the delirium and mania. They are not developed in the same intensity and of equal duration by any other poison, but it is not known what changes take place in the brain. In striking contrast to the case of man, it is stated that no similar effects have been observed in animals. The cerebral symptoms appear to be attributable to iodoform which circulates unchanged in the blood. Some of the other symptoms are no doubt due to iodine set free by the decomposition of a considerable portion of the iodoform and to the iodides which some of the nascent iodine forms by combining with the alkalies of the fluids. After iodoform absorption, iodine is present in the saliva, perspiration and other secretions, but it is found to be chiefly excreted in the urine in the form of iodides. The elimination from the tissues seems to be very slow, since iodides are stated to have been detected in the urine more than a month after the administration of iodoform. When renal disease is present, the drug should always be used with caution, as under these circumstances excretion takes place even more slowly than usual, and the iodoform products are liable to accumulate in the tissues. The cardiac acceleration noted is thought to be probably caused by abnormal activity of the cells of the thyroid gland, as the thyroid secretion has been found to be very considerably increased by iodoform, like other substances from which iodine is liberated in the tissues. Children, it is stated, are less susceptible to the poisonous effects of iodoform than adults. While the drug is absorbed slowly by the alimentary canal, it is taken up quite freely in wounds, and many cases of poisoning have occurred in this way.

Therapeutics of Iodoform.

External.—Whatever may be the explanation of its local action, there can be no question of the great practical value of iodoform as a surgical dressing. In the last twenty years it has had an enormous vogue, and while, on account of its extremely disagreeable odor and the numerous accidents which have attended its use, various substitutes for it have been proposed and have proved more or less successful, it is still employed to a very considerable extent. To attempt to recount all the various conditions in which it has proved of service would be an interminable task, and is unnecessary here. One of its most important applications, and that which first directed general attention to its usefulness, is as a dressing for wounds. The common practice is to sprinkle it freely upon the part and secure it in place by a dry dressing. Since iodoform is not, as explained above, itself antiseptic, it must, before being used, be either sterilized or disinfected by washing in a 1 to 2000 solution of corrosive mercuric chloride solution, and preserved, while damp, in closed sterilized jars. It is employed in the treatment of all sorts of wounds, ulcers and sores, and is found especially serviceable in tuberculous and syphilitic ulcerations. Usually the dry powder is simply dusted upon them, but iodoform is also employed in a variety of different combinations. One of these is a solution in collodion (1 part of iodoform to 12 of flexible collodion), which is painted over wounds, venereal sores, etc., with good effect. Another is a mixture of equal parts of iodoform, glycerin and alcohol, which is used for injecting tuberculous abscesses. For the relief of chronic cystitis injections have been given of iodoform dissolved in ether (1 in 8), of iodoform, starch and water, and of a solution of iodoform in glycerin and water. The latter may be made as follows: Iodoform, moistened with alcohol, 1; boiling water, 2; glycerin 7, and it is also useful for injection into abscess cavities, sinuses, etc. In fissure of the anus and diseased and painful conditions of the rectum an iodoform suppository containing .20 gm. (3 gr.) in .80 gm. (12 gr.) of oil of theobroma serves an excellent purpose. Similar vaginal suppositories have been largely used in affections of the uterus and vagina, and powdered iodoform is sometimes introduced into the dilated cervix uteri by insufflation. In the uterus, the urethra and the nose, as well as in sinuses and other deep and narrow cavities, bougies made with cocoa-butter, mucilage and glycerin, or gelatin, may be employed. Mixed with bismuth subnitrate and starch it is used with benefit, by insufflation, for ozæna, ulcers of the mouth and fauces, and tuberculous ulcerations of the larynx. Syphilitic ulcers of the pharynx are sometimes treated also with the ethereal solution and with gelatin lozenges each containing .06 or .12 gm. (1 to 2 gr.) of iodoform. In ozæna, whether of the simple or syphilitic form, iodoform may be used in an ointment prepared with vaseline, or by means of absorbent cotton impregnated with it, instead of by insufflation. Iodoform cotton is useful as an application to the rectum and vagina, as well as the nostrils. In various forms iodoform is employed to a considerable extent in diseases of the eye and ear. In chronic suppuration of the middle ear, but more especially of the internal auditory canal, it is regarded by many as excelling all other applications in diminishing the discharge, correcting its fetor, and restoring the part to its normal condition. Iodoform gauze, which may be made by saturating the material with a concentrated ethereal solution and afterwards drying, is much used in operations involving the peritoneum, intestine, etc., and in contused wounds where good drainage is required. It is efficient also in the treatment of open cancer, buboes, boils and carbuncles after incision, many of the lesions of scrofula, lupus and syphilis, and a variety of other conditions. A 4 per cent. solution of iodoform in oil of turpentine, administered in the form of inhalation, may sometimes be used with advantage in laryngeal tuberculosis, bronchorrhœa, and other affections of the respiratory apparatus, and good results have been reported from iodoform injections in the treatment of goitre and of tuberculous joints and lymphatic glands. A number of cases of tuberculosis of the bladder are reported to have shown more or less improvement under the use of a mixture of iodoform and vaseline. A novel use has recently been made of the drug, in the form of "iodoform plugs," employed for filling up cavities produced by diseased tissues, and the treatment is stated to have been especially successful in bone cavities. They are composed as follows: Iodoform, 3 to 6; spermaceti, 4; oil of sesame, 2. In exceptional instances iodoform, instead of having a healing and beneficial effect upon wounds, sores, ulcers, etc., causes marked irritation, necessitating its replacement by other applications. As the disagreeable odor of iodoform constitutes a very serious objection to its use, various means have been tried to obviate this, but none of them with very marked success. Among the agents which have been employed to conceal the odor may be mentioned musk, cumarin, creolin and balsam of Peru, and the oils of eucalyptus, turpentine, bergamot, geranium, peppermint, sassafras, cinnamon, lavender and thyme. Of these, oil of geranium (1 to 25) is probably the best. Some believe that the odor of iodoform is preferable to that of musk. By keeping a Tonka bean or ground roasted coffee with it, the odor is lessened. It is claimed that the odor will rapidly disappear from the hands of the surgeon if they be washed with orange flower water or with flaxseed meal in water. It has been pointed out also that as chloroform and ether are solvents of iodoform, they may be successfully used for removing its odor from the hands, nails and clothing.

Internal.—On account of the great success of iodoform in surgery as a supposed antiseptic, it was anticipated that it would prove of decided benefit internally in many of the infectious diseases, and, on account of the large amount of iodine in its composition (with the advantages of being non-irritant and having an organic nature), more especially in such affections as syphilis, scrofula and tuberculosis. It was therefore given an extended trial, both by the mouth and by subcutaneous injection; but the expectations in regard to its efficacy were not at all realized, and although occasional reports of its use in various affections still continue to be published, it has been practically abandoned as an internal remedy by the mass of the profession.

TOXICOLOGY.

Many deaths have been occasioned by the too free use of iodoform as an external application, and in the aged especially more or less severe poisoning is liable to occur from this cause. A surgeon who has employed iodoform in several thousand cases without a single instance of poisoning attributes this favorable result to the following circumstances: that he did not use large quantities of the remedy, that the wound was not subjected to pressure, and that phenol was not employed at the same time. It is a recognized fact, however, that in certain individuals there is an idiosyncrasy which renders them peculiarly susceptible to the action of the iodides in general, and often particularly so to iodoform. It has been found that in some instances this idiosyncrasy develops suddenly and without warning; grave toxic symptoms occurring at once and death quickly ensuing, notwithstanding the withdrawal of the remedy. The following test for iodoform intoxication is of value if the patient is not at the same time using other preparations containing iodine: A few drops of the urine is mixed with a small quantity of calomel on a white plate, by means of a glass rod; when a well-marked yellow discoloration will be produced if the urine contains sufficient iodine to indicate the absorption of a dangerous amount of iodoform.

Symptoms.—These are described on p. 67.

Post-mortem.—Fatty degeneration of the heart, liver, kidneys and muscles is generally found. Among the other conditions observed are ecchymoses in the kidneys, beneath the endocardium, and in other parts of the body, congestion of the meninges, and reddening of the mucous membrane of the gastro-intestinal tract, frequently associated with degeneration of the epithelial cells.

Treatment.—The first measure to be adopted is the complete removal of all iodoform that has been applied and the washing of the part with a solution of sodium bicarbonate. In the milder cases of poisoning nothing further than this may be required. In more serious cases stimulants are called for, and small doses of tincture of opium frequently repeated, are recommended by some authorities as being especially useful. At the same time elimination should be promoted by sponging the body with warm water and the free administration of diaphoretics and diluents, such as potassium acetate, lemonade, etc. Potassium bicarbonate, .60 gm. (10 gr.) of which may be given every hour, is thought to have the effect of counteracting the toxic effects of iodoform, and potassium bromide, which is more active as a solvent for this substance than any other salt, is also considered an antidote.

ACTION OF IODOL.

Iodol is a cicatrizing agent with properties similar to those of iodoform, as a substitute for which it was first introduced. It is without odor and does not produce stomatitis or nasal catarrh. It is decomposed in the tissues, and iodides are excreted in the urine. Its iodine is said to be less easily split off the molecule than that of iodoform, and it has been found less liable to cause poisoning than the latter; but in very large doses it gives rise to symptoms in animals similar to those produced by iodoform, while its prolonged administration may result in fatal fatty degeneration of the internal organs. Its surgical use is reported in one instance to have occasioned dizziness, marked rise of temperature, vomiting, small irregular pulse of 136, albuminuria, and apathy, which continued for several days. Iodine was found in the urine for two weeks. Experiments have shown that iodol is absorbed quite slowly, and to this fact is attributed its greater safety than iodoform as a topical application. Locally it appears to have a very superficial caustic effect, forming a whitish film on ulcerated surfaces, but not a scab.

THERAPEUTICS OF IODOL.

It may be used for all the same purposes as iodoform, and iodol gauze, cotton, ointment, bougies, pastils, etc., corresponding to those made with iodoform, are now supplied. It is largely employed in powder and also in solutions of various kinds. That known as Mazzoni's consists of iodol, 1; alcohol, 16; glycerin, 34. An ethereal solution (4 gm. to 30 c.c.; 1 dr. to 1 fl. oz.) has the advantage of leaving the remedy deposited, after the evaporation of the ether, in a minutely divided state. In ointment (10 per cent.) it has sometimes been substituted for the iodine preparations. Painted over and around the affected part in a 10 per cent. solution in collodion, it is reported to have proved successful in aborting erysipelas. Internally it has been used in the place of potassium iodide, and it is said to be of value in tertiary syphilis, in quantities of from 0.4 to 2 gm. (6 to 30 gr.) a day. Favorable results are also said to have been obtained with it in diabetes.

Various other iodoform substitutes (not official) are found on the market. The only advantage they have over iodoform is in the matter of odor. The principal ones are the following:

Losophan	contains	80.0	per cent.	of iodine.
Di-iodosalicylic acid	"	66.0	"	"

BORON.

1. **ACIDUM BORICUM.**—Boric Acid. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Cataplasma Kaolini.**—Cataplasm of Kaolin.

2. **Glyceritum Boroglycerini.**—Glycerite of Boroglycerin. (Solution of Boroglyceride.)

3. **Liquor Antisepticus.**—Antiseptic Solution. **Dose, 4 c.c. (1 fl. dr.).**

4. **Unguentum Acidi Borici.**—Ointment of Boric Acid.

2. **SODII BORAS.**—Sodium Borate. (Borax. Sodium Pyroborate.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ACTION OF BORIC ACID AND BORAX.

External.—Experiments have shown that while boric acid and borax are inefficient as germicides, they have some antiseptic power. The growth of almost all forms of bacilli is arrested by a 2½ per cent. solution, but the microbes are not destroyed, and it is stated that even the anthrax bacilli are capable of further growth after exposure to a 4 per cent. solution for twenty-four hours. They would seem, therefore, to be of service as **mild antiseptics,** but to be valueless as disinfectants. A saturated solution of boric acid in broth will prevent putrefaction, and this agent is employed to a large extent in the preservation of milk, meats and other kinds of food. When applied in concentrated form to denuded surfaces, it is somewhat irritating and mildly astringent; in solution, while slightly astringent, it is sedative rather than irritating. Borax has no irritant effect. Its alkalinity renders it a cleansing agent of some efficiency and also adds to its sedative action. Its prolonged use, as well as that of boric acid, is liable to give rise to scaly eruptions of the skin.

Internal.—Taken in moderate amount borax does not affect the digestion and assimilation of food, but larger quantities retard the absorption of proteids and fats and increase the bulk of the fæces. Both borax and boric acid are found to be rapidly absorbed by the bowel, and not to affect the intestinal putrefaction. Their excretion, which occurs principally by the urine, is completed within twenty-four hours. The urine is rendered alkaline by borax, if taken in sufficient amounts; while boric acid, which is excreted in part unchanged and in part as borates, increases its acidity. Borax seems to be excreted unchanged. Both these substances have generally been regarded as having something of a diuretic effect, but so far from this being the fact, the latest researches go to show that the urine is really diminished in amount under their use. Borax is thought by some to have a somewhat stimulating influence upon the uterus, and is said to have produced abortion in certain instances. In some cases even moderate amounts of boric acid and borax have a mild aperient action, while in large doses they are gastro-intestinal irritants, and cause vomiting and purging. Other symptoms produced by toxic quantities are dryness of the throat and dysphagia, profound muscular weakness, lumbar pain and vesical tenesmus, with albuminuria and sometimes hæmaturia, dimness of vision, headache, sleeplessness, and nervous depression; which may be followed by fatal collapse. A rise of temperature is frequently observed, and in the course of two or three days, if death does not previously occur, eruptions which are described as scaly, papular or eczematous, appear upon the skin. When the drugs are given by the mouth it is stated that nausea, vomiting and diarrhœa appear earlier and are apt to be more severe than if they are used in any other way, but the same character of symptoms may result from their free application in the rectum, vagina and other parts. They are rapidly absorbed from all mucous membranes and from lesions, and a number of serious cases of poisoning have been reported from the use of boric acid as an antiseptic dressing. In chronic poisoning, the condition known as **borism,** the symptoms are often much the same as in cases of acute poisoning. The cutaneous manifestations, however, are more prominent, and may constitute the only positive indication of toxic action, though there are generally evidences of more or less renal and gastro-intestinal irritation. Œdema of the face and extremities may occur in consequence of the former, and it is advisable that whenever these drugs are given in full doses, a careful watch should be kept upon the state of the urine. The hair is apt to become dry and fall out, and the eruption on the skin may assume the form of seborrhœic eczema, reddish patches which desquamate like psoriasis, or papules attended with much itching. The commonest form of eruption is said to be a scaly one, resembling seborrhœic dermatitis, but usually attended with much more œdema. In some cases there are marked dryness of the skin and mucous membranes, with fissuring of the lips and striation of the nails, and a blue line, resembling that of lead poisoning, has been observed upon the gums. The question of the effect of the continued and habitual introduction into the body of boric acid or borax, as employed in the preservation of food, is one of interest. The results of recent careful experiments conducted by the Bureau of Chemistry, United States Department of Agriculture, show, on the whole, that one half gramme (7½ grains) a day is too much for the normal man to receive *regularly;* while on the other hand the normal man can receive one half gramme of boric acid, or of borax expressed in terms of boric acid, for a limited period of time without much danger of impairment of health. The main objection to the use, as food preservatives, of these and other antiseptics which are harmless in small doses seems to rest upon the fraud in permitting inferior goods to be disposed of as a first-class article. This applies particularly to meats and milk, although the addition of small quantities may sometimes be beneficial by delaying the souring of the latter. If larger amounts are used for fraudulent purposes, the milk is apt to be kept too long and be of inferior quality, while the quantity of preservative may be sufficient to prove injurious to infants taking it habitually.

THERAPEUTICS OF BORIC ACID AND BORAX.

External.—These drugs are used to a much greater extent externally than internally, and, especially on account of their non-irritating qualities, are largely employed as local antiseptics. Occasionally they are used in powder. The saturated solution of boric acid (4 per cent.) may be applied to wounds, ulcers and sores to protect them against infection or decomposition. It is efficacious in phlegmonous erysipelas and in a number of chronic scaly and parasitic skin eruptions. It is especially recommended in the troublesome form of tinea known as *trichophytosis genito-cruralis,* which affects the scrotum and inner side of the thigh, and it is considered the best remedy for fetid perspiration. It is also of service as an injection when there are purulent discharges, as in otorrhœa and leucorrhœa, and to wash out cavities after operations. The irrigation should not be continued too long, however, as toxic symptoms have been produced in this way. The same caution applies to washing out the large intestine with this solution, which has been found of service in colitis; tannic acid being sometimes added to it. Boric solutions, the strength of which may be varied according to circumstances, are very useful in conjunctivitis and other inflammations of the mucous membranes, and, applied upon lint or absorbent cotton, as a dressing for burns and scalds. The Glyceritum Boroglycerini, well diluted, also answers well as an antiseptic wash in ophthalmia, ozæna, pharyngitis, urethritis, vaginitis, etc., and likewise for wounds and granulating surfaces. For washing out the bladder in cystitis Thompson's fluid (consisting of borax, 1; glycerin, 2; water, 2), diluted with eight times as much water, is commonly employed; and one of the most important antiseptic solutions is that of Thiersch, consisting of boric acid, 12; salicylic acid, 2; water, 1000. A glycerin (borax, 1; water, 2; glycerin, 4), and a honey of borax (borax, 2; glycerin, 1; clarified honey, 16), are much used in aphthous sore mouth. This is also often treated by the application of borax mixed with powdered sugar. The following is an excellent mouth-wash: Glycerin of borax (*see above*), 6; tincture of myrrh, 1; water, to 48. For sunburn, pruritis and other skin affections, as well as for wounds, ulcers, etc., boric acid ointments such as the official one will often be found serviceable. Lister's ointment consists of boric acid, 1; white wax, 1; paraffin, 2; almond oil, 2. Greene's ointment is prepared by melting one part each of spermaceti and white wax with six parts of vaseline, and adding, while hot, two to four parts of a saturated glycerite of boric acid. For application to extensive burns it would be advisable to dilute most of these ointments. Boric lint and boric cotton, made by steeping the materials in a saturated solution of boric acid at the boiling-point, are used to a considerable extent in surgery, gynæcology, etc. The external use, as well as the internal administration, of boric acid and the borates should be employed with caution when disease of the kidneys is present. Boric acid may be used to preserve solutions intended for hypodermatic use.

Internal.—Internally boric acid is almost exclusively given for correcting the fetor of fermentative dyspepsia and in cases of cystitis with decomposing urine, where it is also used in solution for irrigation of the bladder. In ammoniacal cystitis it tends to render the urine acid (probably by checking the fermentation; and also because it is excreted in part as boric acid), and has a beneficial effect upon the vesical mucous membrane. It should be given in full doses, in diluted watery solution, and its administration should occasionally be suspended. Borax is sometimes of service in relieving irritability of the bladder. Although at one time several observers reported beneficial effects from the use of the latter drug in typhoid fever, the treatment never won the confidence of the profession, and has been practically abandoned. It has been tried to a considerable extent in epilepsy, but for the most part with disappointing results. While far less efficient than the bromides, it is, in the quantity in which it is required to produce any effect in this disease, much more dangerous. It is said to be apparently of most service in cases where these agents fail and in those in which the epilepsy is associated with gross organic disease. Among the other conditions in which it has been employed are dysmenorrhœa, amenorrhœa and uterine hæmorrhage, as well as inertia of the uterus during labor. It is sometimes taken in very large doses for the purpose of criminally causing abortion. That it really has any action on the uterus would seem to be problematical. It is thought by some to be of value as a solvent for uric acid calculi; but here again grave doubts have been expressed as to its efficacy. The unpleasant taste of borax may be covered with licorice, or, preferably, with syrup of orange-peel.

POTASSIUM PERMANGANATE.

POTASSI PERMANGANAS.—Potassium Permanganate. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

ACTION OF POTASSIUM PERMANGANATE.

External.—Kept dry, it is a permanent salt, but in the presence of moisture it rapidly gives up its oxygen and is converted into manganese dioxide. In powder it has some effect on living tissues, and acts as a mild caustic. In concentrated solutions it causes irritation and even corrosion of the skin. When a solution comes in contact with proteids, such as albumin, it at once parts with some of the oxygen which it contains, and the latter unites with the albumin. It is therefore a powerful oxidizing agent and, in consequence, is poisonous to protoplasm. It has very considerable germicidal activity, but this is short-lived for the reason that it so quickly parts with its oxygen; after which it becomes inert. Experiment has shown that 0.12 per cent. (1 part in 833) will destroy the micrococci of pus in two hours. Except in very superficial infection, however, its antiseptic value is smaller than that of many other agents, since, on account of the rapidity of its reduction, it fails to penetrate deeply, and its action is limited to the skin and the surface of the mucous membranes. Within a limited sphere it is a very efficient **disinfectant** and **deodorant.**

Internal.—It is not absorbed in sufficient amount to have any general action. When taken in poisonous quantities, the resulting phenomena are entirely local. This local action is manifested in gastro-enteritis and irritation or inflammation of the kidneys. The lack of general action, according to some authorities, holds true even when it is introduced into the circulation by subcutaneous or intravenous injection. According to others, in acute poisoning the blood-pressure falls, from depression and paralysis of the vaso-motor centre, while the heart is not affected until much later. Injected thus into the circulation, it is excreted principally by the intestinal epithelium and to a smaller extent by the kidneys. When taken by the mouth, very little appears to be absorbed from the stomach and intestine. In the mouth weak solutions of potassium permanganate have a sweetish but astringent and unpleasant taste, and there, as well as in the stomach, it is quickly reduced to the dioxide and loses its oxidizing power. On account of its caustic action this remedy, when taken in the form of pills or tablets, sometimes occasions considerable gastric irritation and pains. In the blood of man and animals traces of manganese are very frequently found, but it has been shown that this metal is not an essential constituent of the body; being apparently absorbed accidentally with the food. The theory that manganese salts could replace iron in the body has been proved to be untenable.

THERAPEUTICS OF POTASSIUM PERMANGANATE.

External.—One objection to its use, when large quantities are required, is its expense. Another objection is that it stains fabrics. The stain may be removed by the application of sulphurous acid, but as this results in the formation of sulphuric acid, the fabric should be promptly rinsed in water. As an antiseptic it may be used to wash wounds, sores and ulcers in a solution of the strength of 4 gm. (1 dr.) to 500 c.c. (1 pint). For application to mucous membranes, as in a gargle or lotion for swabbing the throat in diphtheria, scarlet fever, and other diseases, the proportion should be about 1.20 gm. (20 gr.) to 500 c.c. (1 pint). Such solutions are employed in necrosis of the jaw, cancer of the tongue, and generally in affections causing foul breath. They are useful also for correcting fetor in various other conditions, such as ozæna, bromidrosis of the feet, etc. Solutions of the strength of .06 to .26 gm. (1 to 4 gr.) to 500 c.c. (1 pint) may be employed as injections for gonorrhœa and leucorrhœa, and for washing out the stomach, bladder, uterus, abscess cavities, etc. One advantage connected with the use of potassium permanganate in this way is that it can be readily seen when it has lost its efficiency by the change in the color of its solutions. As soon as it has become reduced to the dioxide, by giving up its oxygen, these turn dark brown, and so long therefore as such injections return with their pink color retained, the assurance may be felt that the parts are being properly cleansed. It is asserted that potassium permanganate, owing to its properties as an oxidizing agent, is the most efficient antidote to snake-venom, if placed in the wound before the poison is absorbed. It is also recommended that it should be injected subcutaneously about the seat of the bite. As a local application in erysipelas its solutions have been found beneficial. As a deodorizer for sputa, stools, drains, etc., and for washing utensils it is used in the proportion of about 1 to 150. Condy's fluid is a solution of 50 gm. (8 gr.) of the permanganate in 30 c.c. (1 fl. oz.) of distilled water. Potassium permanganate is one of the best known disinfectants for the hands. They should be washed in its saturated solution, which stains them a deep purple, and immediately decolorized with a saturated solution of oxalic acid.

Internal.—On account of its disagreeable taste, potassium permanganate should preferably be given in the form of pills or compressed tablets. As many substances tend to reduce it, it is considered best that the pills should be made with kaolin and soft paraffin, but cacao butter and rosin cerate are also used as excipients. For the dyspepsia and flatulence which so constantly accompany excessive fat, and also for the reduction of the obesity itself, the permanganate is a remedy of considerable value. It often affords relief to patients suffering from lithæmic conditions, with pain in the lumbar region and intestinal indigestion, associated with frequent micturition, acid urine, and much brick-dust sediment; while it favors the conversion of uric acid into urea, and thus tends to prevent the formation of uric acid calculi. On account of its oxidizing properties it is also sometimes of service in acute rheumatism. Potassium permanganate has been much extolled as an emmenagogue, but in the large doses in which it is advised for this purpose (12 to 30 gm.; 2 to 5 gr.), it is almost certain to create gastric disturbance. Very few stomachs will tolerate more than one grain, and as it is in fact reduced in the stomach to the dioxide, that salt is preferable in amenorrhœa. If manganese is of any use in anæmia, which has not yet been proved, it probably acts in the same way as iron. The iron-manganese preparations, so much lauded, owe their efficiency, if they possess any, to the iron which they contain in varying amounts. Potassium permanganate oxidizes morphine, and is therefore an antidote to morphine poisoning. About two grains in solution should be given for each grain (estimated) of morphine swallowed, and the stomach should be immediately and repeatedly washed out with repetitions of the antidote, because it has been shown that during the acute stage of morphine poisoning there is a continuous excretion from the walls of the stomach of the morphine, which is subsequently reabsorbed either from the stomach or the intestine. Potassium permanganate has also been recommended, internally as well as locally, in snakebite and erysipelas, and in septicæmia and puerperal fever.

HYDROGEN DIOXIDE.

AQUA HYDROGENII DIOXIDI.—Solution of Hydrogen Dioxide. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF HYDROGEN DIOXIDE.

Hydrogen dioxide readily **yields oxygen** to all oxidizable substances. When taken internally it gives oxygen to the blood, stimulates the nervous system, and increases urinary secretion. In the blood the oxygen set free may cause the formation of emboli and lead to serious consequences. A death is recorded in which the fatal result is thought to have been due to this cause (the solution of hydrogen dioxide having been employed to wash out the pleural cavity); and in several instances hemiplegia is said to have been observed, apparently from embolism of the cerebral arteries. The different organs and tissues have been found to vary considerably in their power of causing the catalytic decomposition of the dioxide, the red corpuscles of the blood and the liver cells being the most active, and it is now believed that this action of the tissue cells is closely associated with the presence of nucleo-proteids, and not with ferment action, as formerly held. It is a non-poisonous and powerful antiseptic. It decomposes pus and probably destroys the microbes of suppuration. Its antiseptic activity is of comparatively short duration, however, ending as soon as all the oxygen is liberated.

THERAPEUTICS OF HYDROGEN DIOXIDE.

Hydrogen dioxide seems to have a favorable action in some forms of dyspepsia, and to improve digestion. In diphtheria it is useful as a cleansing agent and for absorbing false membranes, and it should be used on glass or hard rubber instruments. Some commercial preparations are very acid, and therefore too irritating for this purpose. This acidity may be neutralized by adding twice its quantity of lime water. It will check bleeding, but from small vessels only. It is of great value in cleansing wounds, ulcers and fistulous tracts, and for surgical dressings; the cessation of frothing indicates the destruction of pus. But the converse of this is not true, for it will froth with perfectly normal blood. It should not be injected into a suppurating cavity unless there is a free outlet for the escape of the gas which is formed. Its most popular use is for bleaching the hair, and in hirsuties it has been found to retard the growth of hair. It is employed to a considerable extent as an injection in gonorrhœa on account of its activity in destroying the gonococcus and arresting the formation of pus. It is also useful in the treatment of leucorrhœa, otorrhœa, ozæna, tonsillitis, chancre, etc., and has proved of service as an irrigating agent in ulcerative blepharitis, purulent conjunctivitis, granular conjunctivitis, and other eye affections. A useful application of the dioxide is in the treatment of gunpowder burns, in which it is stated to absolutely remove the black stain which ordinarily remains permanently. The solution (U. S. P.) should be applied on the first or second day after the burn, and in such a way that it may get thoroughly into the centre of each pigment spot. It is necessary to prick each point well open, when the bubbling resulting from the use of the dioxide will remove the inorganic remains of the powder. Hydrogen dioxide has been highly recommended as a local anæsthetic. Injected under the epidermis it is claimed that it produces immediate and complete analgesia of the whole skin, and it is stated to have been used successfully in this way for opening abscesses, cutting off the redundant tissue of ingrowing toe-nails, opening the pleural cavity, and even performing laparotomy. It is a well-recognized fact that a small amount of the solution, poured over the closely adhering dressing of a wound, will not only relieve the pain incident to the removal of the dressing, but also alleviate any irritation that may be set up. Good results have been reported from the use of the vapor of hydrogen dioxide in the treatment of whooping-cough. A solution of the strength of 12 volumes is employed, and of this 80 gm. (3 oz.) is poured upon a linen cloth about three feet square, which is suspended in the room occupied by the patient. It is advised that two small rooms should be used, one for the day and one for the night, and that the solution should be replenished every four hours. Internal treatment may be given at the same time. In cases of persistent vomiting repeated sips of a weak solution sometimes prove efficient. The claims that have been brought forward for the utility of hydrogen dioxide in low fevers, epilepsy, diabetes, uræmia and other grave constitutional states have never been substantiated, and it appears to possess no distinct value in internal medication. Its use by hypodermatic injection is attended with special risk, on account of the liability to the formation of emboli, which may either plug up the cerebral arteries or, lodging in the lungs, produce fatal asphyxia.

SULPHUR.

1. **SULPHUR SUBLIMATUM.**—Sublimed Sulphur. (Flowers of Sulphur.) **Dose, 4 gm. (60 gr.).**

2. **SULPHUR PRÆCIPITATUM.**—Precipitated Sulphur. (Milk of Sulphur.) **Dose, 4 gm. (60 gr.).**

3. **SULPHUR LOTUM.**—Washed Sulphur. **Dose, 4 gm. (60 gr.).**

Preparation.

Unguentum Sulphuris.—Sulphur Ointment.

ACTION OF SULPHUR.

External.—Sulphur is itself entirely inert, and whatever effects it has upon the system, whether internal or external, are due to the agency of sulphides resulting from solution in the secretions and of hydrosulphuric acid (H_2S), or hydrogen sulphide. The sulphides, being weak salts, readily yield themselves to the formation of the free acid. Although they themselves no doubt have some irritant action, in addition to that of the latter, hydrogen sulphide differs from them in being an acid, with extremely marked irritant properties, and also in being a gas (sulphuretted hydrogen). It is a very powerful poison, which even in small amount is destructive to most forms of life. Thus it has been found that the microbes of putrefaction, which produce it themselves, are eventually killed by it, unless it escapes freely. Its toxic effects on the system are due in part to its local irritation and in part to direct action on the brain and medulla. When inhaled in concentrated form it produces death almost instantly, and a very dilute vapor of it induces irritation of the eyes, nose and throat and a reflex increase in the secretion of tears, saliva and mucus. Upon the skin and mucous membranes sulphur has a stimulant, irritant effect and also a **parasiticidal** and **antiseptic** action. The conversion of free sulphur into sulphides is ordinarily a somewhat slow process, and as it can exert any influence only in proportion to the extent to which such conversion takes place, the **irritation** produced by it is apt to be **mild and prolonged.** This, it has been pointed out, is the secret of its therapeutic success. Applied to skin already inflamed, however, it is apt to act as a severe irritant, and to raw surfaces, such as wounds and ulcers, as a powerful caustic. The sulphides, in contact with the skin, have a solvent action upon the horny epidermis and the hair. Absorption may take place from the cutaneous surface, as well as the alimentary canal.

Internal.—When sulphur is taken by the mouth, much the larger portion of it passes without change through the alimentary canal, and is so discharged in the fæces. The remainder is converted by the alkaline fluids of the intestine into sulphides, which form some hydrogen sulphide and, after being absorbed into the blood, are oxidized rapidly and excreted principally by the urine, as sulphates and in obscure organic combination. In some instances experiment has shown the urea in the urine to be considerably increased, but whether the nitrogenous waste is as a rule augmented by the sulphides has not as yet been determined. A small amount of the converted sulphur is excreted by the lungs, in consequence of which the characteristic odor of hydrogen sulphide may be imparted to the breath. The sulphur compounds, by reason of their irritant effect, act locally upon the intestine, causing increased peristalsis and **mild purgation**, with soft stools and but little griping. They also have an **antiseptic action in the intestines.** Under large doses of sulphur the symptoms of intestinal irritation may be more severe than those mentioned, the evacuations assuming a bloody character. The drug has a slight **diaphoretic** action, the cutaneous secretions being stimulated to some extent during its elimination. Hydrogen sulphide is excreted in minute amount by the skin (so that silver articles about the persons of those taking sulphur may be discolored), and also in the milk of nursing women. When injected intravenously in mammals the sulphides induce violent convulsions, which are apparently of cerebral origin, since it has been shown that they do not occur in the hind limbs after section of the spinal cord. Their action on the blood is to reduce the oxyhæmoglobin and so diminish the processes of oxidation, while at the same time there is formed a compound known as sulpho-methæmoglobin or as sulpho-hæmoglobin, which is considered more nearly related to methæmoglobin than to hæmoglobin. The blood changes were formerly supposed to be the cause of death in poisoning, but it is now known that this is owing to direct action on the central nervous system. The respiration, which is at first accelerated, later becomes dyspnœic and finally ceases; the fatal result being due to this, together with the paralysis of the vaso-motor centre. The heart is apparently affected only indirectly through the failure of respiration and the fall of blood-pressure. While the effects of sulphur are due entirely to the action of the sulphides and hydrogen sulphide into which it is changed in the intestine, therapeutically it is never given in sufficient amounts to elicit the toxic action of these agents upon the system. Clinically, advantage is taken of its especial tendency to act upon the skin and mucous membranes.

THERAPEUTICS OF SULPHUR.

External.—Inunction with sulphur has always been considered the typical remedy for scabies, but at the present time balsam of Peru, which makes an efficient and much more agreeable application, is used to a considerable extent in its stead. The sulphur treatment should be inaugurated with a warm bath lasting about twenty minutes, after which the patient should be scrubbed all over, with the exception of the head and face, with soft soap or potash, for the purpose of breaking open the furrows and exposing the acari or itch-insects. Next, the surface should be rinsed with clean water and dried, and then sulphur ointment should be thoroughly rubbed in with friction. The official ointment in full strength sometimes gives rise to an erythematous or papular, eczematous or pustular, eruption, and it is therefore generally well to dilute it. The following application may be used: Oil of cade, 4 c.c. (1 fl. dr.); sulphur ointment, 8 gm. (2 dr.); lanolin, 19.5 gm. (5 dr.). The patient should then go to bed, sleeping in flannel, and the next morning should wash himself clean and put on clean underclothing. One such application is generally sufficient to effect a cure, but it may be repeated once or twice. In order to prevent reinfection by the parasite, the bed linen and the clothing previously worn should either be destroyed or disinfected by baking or thorough boiling. Sulphur is also employed for pediculosis and the various forms of tinea, as well as chronic acne, rosacea, eczema, psoriasis, and other skin diseases. In acne of the face it should be used with caution, especially if the sebaceous follicles are in a patulous condition, as the sulphur, getting into their openings, is liable to cause black points. Many of the parasitic affections are best treated by means of sulphur-vapor baths, and potassium sulphide baths are useful in syphilis. Insufflations of powdered sulphur are sometimes made into the throat or nose in diphtheria, scarlet fever, and other infectious diseases, and ointments containing sulphur have been applied to the skin in scarlet fever, measles, small-pox and erysipelas. In alopecia circumscripta sulphur is sometimes of service in promoting the growth of the hair. Associated with live steam, the fumes of burning sulphur may be relied upon to disinfect rooms, ships, etc. Moisture is essential for the success of the process. (*See* Sulphurous Acid, p. 91.)

Internal.—The continued use of small doses of sulphur may prove useful in such affections as acne, sycosis, psoriasis and chronic eczema, and especially when the upper layer of the skin and the glands are affected, as well as in loss of hair and diseased conditions of the nails. It is a very good laxative, especially for children, and washed sulphur is one of the ingredients of the popular compound liquorice powder (*see* Senna). A sulphur lozenge may contain .30 gm. (5 gr.) of precipitated sulphur and .06 gm. (1 gr.) of acid potassium tartrate, and one or two of these at night generally answer very well in cases of mild constipation. On account of its lack of griping and the softness of the stools it causes, sulphur is very useful in piles, fistula and other rectal affections, and as a laxative after operations upon the pelvic organs. It is also thought to be of service in disordered conditions of the liver, for which the various mineral waters containing sulphur and its salts may likewise prove beneficial. Such waters, as for instance those of Richfield Springs, are useful for chronic rheumatism, as well as for chronic sore throat, bronchitis, etc., especially associated with digestive difficulties or a gouty or rheumatic diathesis, and for lead poisoning and various skin diseases, including the late secondary eruptions of syphilis. They are used both internally and in baths.

4. **SODII SULPHIS.**—Sodium Sulphite. **Dose, 1 gm. (15 gr.).**

5. **SODII BISULPHIS.**—Sodium Bisulphite. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

6. **SODII THIOSULPHAS.**—Sodium Thiosulphate. **Dose, 1 gm. (15 gr.).**

ACTION OF SODIUM SULPHITE, BISULPHITE AND THIOSULPHATE.

They tend to **arrest putrefaction** and other forms of fermentation, being moderately powerful antiseptics for the reason that they withdraw oxygen from organic matter in order to oxidize themselves to sulphates. Injected into animals they have a decidedly toxic effect. In frogs they produce paralysis of the central nervous system (commencing in the brain and descending to the spinal cord), and of the muscles and peripheral nerve endings, and the heart comes to a standstill in diastole. In mammals the action is exerted chiefly upon the medulla oblongata and the heart, and the respiration fails a little before the latter. As they are slowly absorbed from the alimentary canal, and a portion is changed to the harmless sulphate before reaching the blood, much larger quantities are required to poison animals by the mouth than by subcutaneous injection. Large doses of sulphite have been taken by man without the production of toxic symptoms, but most of the preparations are said to contain a very considerable amount of sulphate. In some instances comparatively small quantities have given rise to more or less gastro-intestinal irritation. As it has been found that even small doses, when given daily to animals, cause hæmorrhages in different parts of the body, the use of these salts for the purpose of preserving wines, meats, etc., should be condemned.

THERAPEUTICS OF SODIUM SULPHITE, BISULPHITE AND THIOSULPHATE.

Their therapeutic application is of somewhat limited range. Sodium sulphite, in the form of a wash (1 to 8) is of service in aphthous sore mouth, and has also been locally used for various parasitic skin diseases. It may be given with advantage in some forms of gastric fermentation, and is especially useful in yeasty vomiting, where the sulphurous acid liberated from the salt in the stomach by the acid of the yeasty matter has the effect of destroying the microscopic fungi present (*sarcina ventriculi* and *torula cerevisiæ*). It was believed at one time that the sulphites would prove highly efficient in pyæmia and various zymotic diseases, from their supposed action as antiseptics in the blood; but the hopes thus entertained have proved entirely fallacious. Atomized solution of sodium sulphite or thiosulphate may be inhaled in gangrene of the lung,

[illegible]

CALX SULPHURATA.—S[illegible] [illegible] **Dose** [illegible] gr. [illegible] **milligm.** [illegible] gr.

SULPHURIS IODIDUM.—Sulphur [illegible]

ACTION OF SULPHURATED LIME AND SULPHUR IODIDE.

External.—These preparations are irritant and are powerful **parasiticides.** The local action of sulphur iodide resembles that of iodine, and when diluted it is a stimulant to the glands of the skin and aids the absorption of inflammatory exudation.

Internal.—*Sulphurated lime in small doses may cause a sensation of warmth at the epigastrium and also have a slight laxative effect; in large doses, excite gastro-enteritis. It is believed to have a special influence in preventing or limiting suppuration. The action of sulphur iodide is essentially that of iodine, the proportion of sulphur not being sufficient to produce any effect in the small doses in which alone it can be given.*

THERAPEUTICS OF SULPHURATED LIME, AND SULPHUR IODIDE.

External.—*Scabies may be cured by ointments made with either of these substances, but Vleminckx's solution, which is made by boiling 165 parts of freshly slacked lime with* [illegible] *parts of sublimed sulphur in water, sufficient to make* [illegible] *parts, and the active agent of which is calcium penta-*[illegible] [illegible] *ointment. It should* [illegible] *brush or a piece of lint.* [illegible] *diseases are sometimes treated with* [illegible] *sulphurated lime in imitation of the* [illegible] *as are* [illegible] *An ointment* [illegible] *is useful in ring-*[illegible] *as well as in lupus vul-*

garis and other forms of cutaneous tuberculosis and in rosacea and acne indurata. If there is much irritation present, it should be used in greater dilution. An objection to the ointment is its tendency to speedy decomposition.

Internal.—Sulphur iodide is rarely given internally. In order to obtain the effects of sulphurated lime on the process of suppuration the dose should be repeated at very frequent intervals. It is useful in the prevention and treatment of styes, boils, carbuncles, abscesses, etc. It has also been used with advantage in acne, ezcema, ophthalmia and sores in scrofulous children, the suppuration of tuberculous glands, and acute tonsillitis, especially in strumous patients; and one case of elephantiasis is recorded in which it was successfully employed. The natural sulphide waters, such as those of the Blue Lick Springs of Kentucky, which are said to be almost identical with the well known Harrowgate water of England, are beneficial in habitual constipation from deficient intestinal secretion, and in obesity, engorgement of the pelvic viscera in women, and hæmorrhoids in both sexes, when dependent upon torpid portal circulation. Their prolonged use has also been attended with good effects in glandular affections, hepatic, splenic, prostatic, etc. They should be discontinued when anæmia is threatened, and if given at all in anæmic subjects should be associated with suitable tonic treatment. In France sulphur iodide is asserted to have proved of great service in human glanders.

9. ACIDUM SULPHUROSUM.—Sulphurous Acid. **Dose, 2 cc. (30 ♏).**

ACTION OF SULPHUROUS ACID.

External.—Sulphurous acid is characterized by its strong affinity for oxygen and is a **disinfectant, deodorizer and parasiticide.** Through its powerful reducing action it becomes oxidized to sulphuric acid, and is rendered highly poisonous (independently of its acidity) to parasitic organisms, especially those of a vegetable character. By it the activity of unformed ferments is also abolished or diminished. Thus, it has been found that 1 part in 1300 will arrest the action of pepsin, 1 in 8600 that of ptyalin and diastase, and 1 in 20,000 that of myrosin and emulsin. The official solution has no effect upon the unbroken skin, but is more irritant to raw surfaces than many other equally powerful antiseptics. It is also strongly irritant to mucous membranes.

Internal.—In concentrated form sulphur dioxide is entirely irrespirable, causing spasm of the glottis. Even when inhaled in the strength of 5 parts in 10,000 the gas is decidedly irritant to the respiratory mucous membrane, and when a little less diluted excites catarrhal inflammation of the tract. It penetrates the tissues more rapidly than most other mineral acids. In solution it has the same irritant action on the mucous membranes as others of equivalent strength, while upon the contents of the stomach it has an antiseptic effect and also interferes with the action of the digestive ferments. It is excreted by the kidneys and alimentary canal in the form of sulphates, to which it is oxidized during absorption and in the tissues. The sulphites are said to be capable of causing death by paralyzing the heart, as well as the respiratory and other motor nerve-centres, but are so rapidly and completely changed into sulphates that unless given in enormous amount they are found to exert very little influence upon the system.

THERAPEUTICS OF SULPHUROUS ACID.

External.—For disinfecting the holds of ships sulphur dioxide, generated from burning sulphur, is largely used associated with steam; but in the case of apartments it has been to a considerable extent replaced by formaldehyde, which is more efficient and does not, like it, injure fabrics. When it is employed for this purpose at least three pounds of sulphur should be burned for each thousand cubic feet of space (the sulphur candles now to be found in pharmacies furnishing the most convenient method), after the room has been rendered as air-tight as possible. The action of the sulphurous acid is much more efficient when the air is saturated with moisture, and if steam cannot be used the walls and floors should be first sprayed with water. The room must be kept closed for about twenty hours. Scabies may be cured very rapidly by exposing the patient, his head excepted, to the action of sulphur dioxide, generated by burning 46.7 gm. (12 dr.) of sulphur in a suitable closed apparatus. Extreme care should be observed, however, to prevent the inhalation of the smallest amount of the poisonous gas. Sulphurous acid, generally considerably diluted, is sometimes employed as a spray or gargle in diphtheria, scarlet fever and septic sore-throat and as a spray in chronic bronchitis with profuse and fetid expectoration. Its local application is of service in thrush, pruritus, and parasitic skin affections, such as the various forms of tinea, as well as for chilblains and for foul ulcers and sloughing or gangrenous wounds.

Internal.—It may be used in cases of dilated stomach, with fermentation and the presence of sarcinæ and torulæ, and of indigestion with pyrosis or the vomiting of acid matters due to acid fermentation of the starchy or saccharine elements of the food; but it should be borne in mind that while it may prevent abnormal fermentation, it is also liable to interfere with the action of the normal ferments. It has been recommended in certain cutaneous diseases, such as urticaria and purpura, after other methods have failed. In the treatment of purpura it may be combined with the fluidextract of ergot.

CHARCOAL.

1. **CARBO ANIMALIS.**—Animal Charcoal.

2. **CARBO ANIMALIS PURIFICATUS.**—Purified Animal Charcoal.

3. **CARBO LIGNI.**—Charcoal. (Wood Charcoal.) **Dose, 1 gm. (15 gr.).**

Action of Charcoal.

External.—Charcoal is an oxidizing agent and a **deodorant.** Owing to its porous character, it is an active absorbent of gases, which become condensed in its interstices. It thus ordinarily contains oxygen in large amount, being capable of absorbing eighteen times its own volume of this substance. The latter, in consequence apparently, of its condensed state, is possessed of special activity. When, therefore, charcoal is brought into contact with decomposing organic matter, it absorbs the gases, which of itself tends to remove the foul odor, while the oxygen effects the oxidation of the matter to its simplest combinations. Charcoal possesses the property of absorbing, in addition to gases, many colloid bodies, such as the coloring matter of plants and proteids, and has the power of oxidizing organic matters in solution or in the solid form. It appears to act when moist almost as efficiently as in the dry state, as is shown by its activity in oxidizing organic impurities in water when charcoal filters are used. In time its power of oxidation becomes exhausted, the rapidity with which this takes place depending upon the amount of organic matter with which it comes in contact; but this may be restored by heating the charcoal to redness. It is incorrect to speak of charcoal as a disinfectant (though it is popularly regarded in this light), as it is not germicidal or antiseptic, having no influence upon living organisms.

Internal.—Charcoal is altogether inert, as regards any effect upon the system, except in so far as by reason of its absorbent and oxidizing properties it may check meteorism and flatulence. By its mechanical action on the intestinal walls it sometimes serves, when taken in large doses, as a mild laxative, and also has some effect in clearing away mucus. It passes through the alimentary canal unabsorbed, and is found unchanged in the fæces.

THERAPEUTICS OF CHARCOAL.

External.—Charcoal makes a cheap and efficient deodorant and absorbent application to cancerous sores with offensive discharges, foul ulcers, gangrenous wounds, etc. As, however, large quantities are required and as it is very dirty, ordinary antiseptic and disinfectant dressings will generally be found more serviceable in such conditions. It may be used as a powder, made into a thin paste with water, or mixed with poultices. The most cleanly way of employing it is in thin bags of fine texture. Charcoal is sometimes used as a tooth-powder, but it should not be recommended, because it abrades the enamel of the teeth and discolors the gums. In pharmacy it is useful as a decolorizing agent and for filtering; but charcoal filters are objectionable in the household because unless renewed very frequently they not only lose their virtues but may become breeding-places for infectious germs.

Internal.—It is most conveniently administered in tablets or capsules, but is sometimes given mixed with water. In some cases charcoal biscuits are preferred. Among the conditions in which it has been found of service are the following: Decomposition of the contents of the stomach, flatulent dyspepsia attended with fetid breath, gastralgia, acidity, heartburn or foul eructations, intestinal indigestion with meteorism, diarrhœa, dysentery, and ulceration of the intestines with foul stools. In choleriform diarrhœa, both in adults and children, finely powdered charcoal, given in milk diluted with water and sweetened, has been found efficient, and in epidemic dysentery good results have been obtained from the remedy, administered both by the mouth and the rectum. In some instances it answers well in the vomiting of pregnancy. Large doses, when not accompanied with a sufficient amount of water, have been known to cause intestinal obstruction. In view of the fact that charcoal has the power of removing alkaloids from solutions, it has been recommended in diseased conditions resulting from the formation in the alimentary canal of toxins and ptomaines of an alkaloidal nature. It is also said to be sometimes useful as an antidote in poisoning by phosphorus and by such alkaloids as morphine and strychnine, by removing the toxic agent from solution. Purified animal charcoal is preferred for this purpose, and it is advised that after its use the stomach should be evacuated by the stomach-pump or emetics. It is stated that 15 gm. (½ oz.) of the charcoal, which should be rubbed up with sufficient water to make a thin liquid, will render inert about .06 gm. (1 gr.) of alkaloid.

THYMOL.

THYMOL.—Thymol. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Preparations.

1. **Cataplasma Kaolini.**—Cataplasm of Kaolin.
2. **Liquor Antisepticus.**—Antiseptic Solution. **Dose, 4 c.c.; 1 fl. dr.**
3. **Thymolis Iodidum.**—Thymol Iodide. (Aristol.)

ACTION OF THYMOL.

Thymol was introduced as a substitute for phenol, which it resembles in its effects though it causes less stimulation of the central nervous system. It is also more slowly absorbed, less irritant to wounded surfaces, and less poisonous to the higher animals and man than that drug. As regards its influence on fermentation and putrefaction, it has been shown to have a very decided **antiseptic** action, but, although considerably more powerfully antiseptic than phenol, it is less soluble in the fluids of the body, and has not, consequently, been able to replace it. A persistent acrid sensation in the fauces is caused by thymol. Although it rarely produces vomiting, large doses cause a feeling of warmth about the epigastrium, and quite frequently excite diarrhœa. In from half an hour to an hour, more or less profuse sweating is apt to occur. It also causes a **reduction of temperature,** but is regarded as less certain and more dangerous as an antipyretic than salicylic acid, to which its composition indicates a close correspondence. Convulsions and tremors are rarely induced in either frogs or mammals, and under toxic quantities the animal, after a stage of gradually increasing weakness and apathy, generally sinks into fatal collapse. Thymol has been found to excite a greater amount of irritation in the kidneys than phenol, and under its use the urine may contain blood, as well as albumin. The urinary secretion is sometimes increased, and is of a dark greenish hue, due to the presence of a green coloring substance. This becomes blue on the addition of acid, and is thought to be nearly related to but not identical with indigo. Experimental research has shown that thymol is excreted in the urine in combination with sulphuric and glycuronic acids, partly unchanged and partly oxidized to thymol-hydroquinone.

THERAPEUTICS OF THYMOL.

The addition of a little alcohol renders possible the preparation of a 1 to 1000 aqueous solution, which for some purposes may require weakening. As an antiseptic surgical dressing and in dermatology thymol has been used in solution and in the form of gauze and of ointment. One objection to its employment is that its odor is likely to attract house flies. Thymol is quite an efficient antiparasitic, and a solution in alcohol or ether (1 in 15) may be employed in ringworm and pityriasis versicolor. An ointment (1 to 50) has proved of service in psoriasis, eczema, acne, alopecia circumscripta, and other skin diseases. In the treatment of burns, especially in children, its application has been recommended in combination with Carron oil (Linimentum Calcis). Thymol is used to some extent in dentistry, and on account of its agreeable taste is quite frequently employed as a detergent antiseptic in ulcerated and diseased conditions of the mouth and fauces. A glycerite (1 in 200) makes a good mouth-wash. A solution has sometimes been used by inhalation with advantage in bronchitis, laryngitis and whooping-cough and as a disinfectant in diphtheria, phthisis and gangrene of the lung. For catarrh of the upper air-passages inhalations of the following mixture are highly spoken of: Thymol, menthol and phenol, each .32 gm. (5 gr.); oil of eucalyptus, 60 c.c. (2 fl. oz.); oil of pine, 90 c.c. (3 fl. oz.); 20 or 30 drops to be placed on a sponge or piece of cotton, or a teaspoonful may be added to boiling water and the steam inhaled. Thymol solutions are useful injections in gonorrhœa and vesical catarrh. Thymol is an internal antiseptic of some value. In gastric and intestinal catarrh it often acts favorably by arresting fermentation and stimulating digestion. In large doses (up to 2 gm.; 30 gr.) it is an efficient anthelmintic for the *Ankylostoma duodenale*. On account of the danger of toxic effects, the patient should be warned not to take any solvent of thymol, such as alcohol, ether, chloroform, glycerin, oils, etc., after the administration of the remedy. A purgative must be administered the day before commencing treatment, and senna is preferred. The diet should not contain too much fat or alkalies, and but little water should be taken. A purgative should also be given twelve hours after the thymol course ends. Senna is the best, but calomel may be used. Thymol may be given in capsules, wafers or gelatin-coated pills; never in solution. The poisonous symptoms of the drug, as has been seen, resemble those caused by phenol. Should these appear the thymol must be stopped, and the bowels promptly evacuated. Thymol, both alone and in combination with gallic acid, is reported to have been used successfully in some cases of chyluria of filarious origin. It is of no practical value as an antipyretic, as the doses required to affect the temperature in fevers are so large as to be extremely apt to cause dangerous depression of the vital powers. Thymol has been recommended in acute rheumatism, tuberculosis, diabetes, typhoid fever, and other constitutional diseases, but has proved entirely inefficient.

ACTION OF THYMOL IODIDE.

Aristol is non-irritant and in its general local action resembles iodoform. It is, however, less desiccant than the latter, as the thymol appears to have some effect in increasing moisture. It possesses the great advantage of being practically odorless. It is claimed to be non-toxic, but it is possible for its prolonged use to give rise to chronic iodine poisoning. It has been demonstrated to have no influence upon the lower organisms, and is not, therefore, directly antiseptic. In regard to its elimination, very little is known, but it would seem to be partially decomposed in the system. Iodine has been found present in the urine of animals to which it was given in considerable quantities, but no traces of thymol have been detected.

THERAPEUTICS OF THYMOL IODIDE.

Aristol has proved in many respects a very useful substitute for iodoform. In surgery when dusted upon serous membranes, however, it tends to prevent their adhesion, and in the treatment of wounds and sores it is contra-indicated when secretion is free. It is used for the same purpose as iodoform in cutaneous affections, such as lupus, psoriasis and eczema, in syphilitic lesions, and in a great variety of diseased conditions of the mucous membranes, and is very efficacious in the treatment of burns. It is employed as a powder and in flexible collodion, solutions in oil or ether, and ointments made with lanolin or vaseline. Heat should not be used in dispensing it, as the iodine in its composition is readily set free; and it should not be mixed with alkalies, metallic oxides, or starch.

OIL OF THYME.

OLEUM THYMI.—Oil of Thyme. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF THE OIL OF THYME.

Its action is antiseptic and somewhat similar to that of copaiba.

THERAPEUTICS OF THE OIL OF THYME.

The chief use of oil of thyme is as a source of thymol. It has been employed in the treatment of bronchitis, gonorrhœa, gleet, leucorrhœa, and vesical catarrh.

BALSAM OF PERU.

BALSAMUM PERUVIANUM.—Balsam of Peru. **Dose, 1 gm. (15 gr.).**

ACTION OF BALSAM OF PERU.

It is a **general stimulant**, with a special tendency to the mucous membranes. On the skin it produces slight reddening, and its external application is occasionally followed by an erythematous, urticarial, or eczematous eruption. It has some **antiseptic** property, and is efficient in the destruction of animal and vegetable parasites. It also allays itching of the skin and mucous membranes. By its stimulating action on wounds and sores it facilitates the repair of tissue. Internally it is **stomachic, carminative and expectorant.** In large doses it may act as a gastro-intestinal irritant, inducing vomiting and purging, but in smaller quantities causes some heat of skin and stimulates the circulation. It is excreted by the skin, kidneys and respiratory mucous membrane, and during its elimination is believed to stimulate and have a tendency to disinfect the secretions from these parts. The fact that in some cases, after large doses, the addition of acid to the urine is followed by the formation of an abundant precipitate has led to the opinion that the drug has an irritant action on the kidneys; but in most instances the precipitate is found to be dissolved by alcohol, which would go to show that it consists of resin, and not albumin. In one instance, however, it is stated that an inunction of 18.5 c.c. (5 fl. dr.) of the balsam gave rise to nephritis and dropsy.

THERAPEUTICS OF BALSAM OF PERU.

External.—Balsam of Peru has long been used, either pure or diluted, as an application to wounds, compound fractures, and indolent sores. As a stimulating dressing for sluggish granulations a 5 to 10 per cent. solution in castor oil is frequently employed. This solution, saturating a number of layers of gauze, over which oiled silk or a starch bandage is applied, is very efficient in maintaining drainage in wounds, abscesses, burns, etc. It is also an excellent deodorant, and is said to cover to a large extent the disagreeable odor of iodoform when it is used in connection with it. Balsam of Peru is a good local application for diphtheria, for chilblains, and for sore nipples and cracked lips, and is useful in moderating the discharge of pus in chronic catarrhal conditions of the nose, the ears, or the vagina. When used for fissured nipples it should be removed before the child is allowed to nurse. One case of fatal gastritis in an infant six days old is recorded which is stated to have been caused by balsam of Peru applied to the mother's nipples. It is one of the best known remedies for pruritus vulvæ and other varieties of pruritus, especially the senile, and is generally applied pure in these conditions. It is successful in removing leucoplakia, or local epithelial thickening of the mucous membrane, and is of considerable service in chronic inflammatory diseases of the skin, especially eczema. One of its principal uses is as a parasiticide in ringworm, pediculosis, and scabies, and for this purpose an ointment consisting of balsam of Peru, 20; olive oil, 50; petrolatum, 100, may be employed. For scabies it should be employed in the same manner as sulphur ointment (*see* p. 87). It is as efficient as the latter, killing the eggs as well as the acarus, and is at the same time much more agreeable to the patient. Sometimes the balsam is used in combination with sulphur.

Internal.—It is often a very useful remedy in chronic bronchitis and bronchorrhœa, as well as at times in chronic intestinal catarrh and dysentery. It has also been employed in the gastro-intestinal disorders of childhood. It may be given alone in capsules or emulsion, or in mixtures with other drugs. It has been claimed that by the use in phthisis of subcutaneous and intravenous injections of balsam of Peru, and its chief constituent cinnamic acid, a specific inflammation of the diseased areas might be set up, which would subsequently result in cicatrization of the tuberculous nodules. Most of those who have employed this treatment, however, pronounce against it, and it has not been received with general favor, as no conclusive evidence has been presented that the alleged effects are produced. At the same time, when given by the mouth or by inhalation, its expectorant action may no doubt sometimes be of more or less service in this disease. Other uses of the balsam are in the treatment of gleet, leucorrhœa and chronic laryngitis (by inhalation).

B. ANTHELMINTICS.

MALE FERN.

ASPIDIUM.—Aspidium. (Male Fern.) **Dose, 4 gm. (60 gr.).**

Preparation.

Oleoresina Aspidii.—Oleoresin of Aspidium. **Dose, 2 gm. (30 gr.).**

ACTION OF MALE FERN.

When given in ordinary doses this drug generally passes through the system, even when some absorption takes place, without giving rise to any symptoms, though there may be slight intestinal disturbance. When large quantities are taken, or if for any reason an unusual amount of its active constituents become absorbed, alarming and even fatal results may be observed. Recently several cases of poisoning have been reported, presumably not due to an excessive dose, but to the fact that castor oil was administered at the same time, with the effect of notably increasing the absorption of filicic acid. The toxic symptoms consist of nausea, vomiting, purging, intense abdominal pain, muscular weakness, cramps in the extremities, tremors, increased reflexes, confusion of ideas, and somnolence deepening into coma, with collapse. The secretion of urine is apt to be diminished. In many cases disturbances of vision, or even complete loss of sight, occur, without any distinct ophthalmoscopic appearances, and sometimes there are convulsions, which may be tetanic in character and accompanied with opisthotonos. In a considerable proportion of instances icterus is present, and is thought to probably result from the duodenal catarrh, though it may possibly be due to destruction of the red corpuscles of the blood. After death the gastro-intestinal mucous membrane is found to be congested, swollen, and sometimes dotted with ecchymoses, and degeneration of the nerve-fibres is also observed. The treatment recommended for poisoning by aspidium is the administration of magnesium sulphate by the mouth and ammonia by subcutaneous injection.

THERAPEUTICS OF MALE FERN.

Aspidium acts as a direct poison to **tape-worms**, and is one of the most certain of all remedies for these entozoa. It is also used against the *Ankylostoma duodenale,* and the ethereal extract of male fern has proved of service in the treatment of cysticercus disease. In cases of the latter the result is stated to have been especially favorable when the lesions were situated in the subcutaneous or muscular tissues. The drug is considered more successful against the *Tænia solium* (the armed variety of tape-worm) and the *Bothriocephalus latus* (for which it is especially efficient) than against the *Tænia medio-canellata.* For a day before taking the medicine the patient should use a liquid diet, such as milk or beef-tea. On the following morning, the bowels having been previously evacuated, he should take, fasting, a full dose of the oleoresin, which may be administered in pills or capsules or in a draught made up with mucilage and flavored with ginger, cinnamon or peppermint. A good way also to give it is with an equal quantity of aromatic syrup of rhubarb. It is sometimes advised that the dose should be repeated in two or three hours. In the middle of the day the patient may eat a full meal, and in the evening should take a brisk cathartic. Castor oil or other oils should not be used, on account of the danger of increasing the absorption of filicic acid, and thus causing toxic symptoms. The head of the tape-worm should be carefully searched for in the stools.

KAMALA.

Kamala (not official).—Kamala. (Rottlera.) **Dose, 4 to 8 gm.; 1 to 2 dr.**

ACTION OF KAMALA.

Kamala is an **anthelmintic**, and also a somewhat drastic purgative. As a rule, it does not cause nausea or vomiting. Since it imparts its virtues to alcohol, a tincture made from it is quite as efficient a vermicide as the powder.

THERAPEUTICS OF KAMALA.

It will kill the *Tænia solium*, and probably also the *Oxyuris vermicularis* and the *Ascaris lumbricoides*. For tape-worm it is customary to give one full dose of the powder, mixed with syrup, to which a little hyoscyamus is added to prevent griping, and the parasite is often expelled dead at the third or fourth stool after the use of the drug. If one dose proves insufficient, it may be repeated every three hours until five or six doses have been taken.

KOUSSO.

CUSSO.—Kousso. (Brayera. Kooso.) **Dose, 16 gm. (240 gr.).**

ACTION OF KOUSSO.

Kousso is an **anthelmintic** and **gastro-intestinal irritant.** It has been alleged that it is capable of bringing on abortion, but such action upon the uterus has never been conclusively shown.

THERAPEUTICS OF KOUSSO.

It is used exclusively in the treatment of tape-worm, and its efficiency appears to depend considerably on the freshness of the flowers employed. Objections to its use are that it is often retained with difficulty and is apt to create intestinal distress. It may be administered in an infusion or in the form of the fluidextract, and should be taken in the morning on an empty stomach.

POMEGRANATE.

GRANATUM.—Pomegranate. **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Granati.—Fluidextract of Granatum. **Dose, 2 c.c. (30 ♏).**

PELLETIERINÆ TANNAS.—Pelletierine Tannate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF POMEGRANATE.

On account of the large amount of tannin which it contains, pomegranate is apt to disturb the stomach and cause nausea and vomiting. It also occasions flatulence and intestinal pain, and sometimes, but not always, acts freely on the bowels. Other symptoms produced by large doses of the drug are general weakness, muscular tremors and cramps, particularly in the leg muscles, hebetude, vertigo, and mental confusion, without loss of consciousness. The urine is increased in quantity. Like male fern, pomegranate frequently causes disturbances of vision and diplopia, mydriasis and amaurosis have been observed.

Pelletierine, the mixture of active principles of pomegranate, in sufficient quantity, acts like curare, causing paralysis of the motor nerves, without affecting sensation or muscular contractility. In the frog it also acts upon the heart muscle, the pulsations being slowed, although they may temporarily increase in force. It has been proved experimentally to have a **specific toxic action on tape-worms**, a solution of one part in 10,000 causing their death in ten minutes, while other intestinal worms were unaffected by stronger solutions. For practical purposes pelletierine tannate is the most effective and least dangerous form of the drug, as its insolubility no doubt prevents its rapid absorption and ensures its prolonged contact with the worm.

THERAPEUTICS OF POMEGRANATE.

Pomegranate is exceedingly unpalatable and is so liable to cause emesis that the purpose of the drug may be thus defeated. When retained by the stomach it is usually an efficient remedy for **tape-worm.** It is best administered in decoction (1 to 5; dose, 15 to 60 c.c.; ½ to 2 fl. oz.), and of this several doses may be taken, fasting, at intervals of an hour. It should be preceded by a brisk cathartic, and, if the remedy does not have a purgative effect, followed by another. In case the patient is unable to take the decoction in this way it is recommended that the requisite quantity should be evaporated in a water-bath to a pilular consistency and administered in capsules, preceded and followed by a cathartic. On account of its powerful astringent properties pomegranate is sometimes employed for the same purposes as tannic acid and other astringent remedies. Thus, the decoction has been used as an injection in gonorrhœa, leucorrhœa, etc., and, flavored wth orange or aromatics, as a gargle for sore-throat and relaxed states of the fauces. Internally pomegranate has been advantageously employed in the diarrhœa and dysentery of hot climates, and also in Ménière's disease.

Pelletierine is one of the most reliable of tæniafuges, and is decidedly preferable to pomegranate itself on account of the facility with which it can be taken and its freedom from nauseating properties. It is usually given in capsules, and, like pomegranate, should be preceded and followed by a purgative. It should be administered with great caution to children. It has been found successful in affording relief in paralysis of the third and sixth nerves.

PUMPKIN SEED.

PEPO.—Pepo. (Pumpkin Seed.) **Dose, 30 gm. (1 oz.).**

ACTION OF PUMPKIN SEED.

Pepo is one of the most efficient and at the same time harmless tæniafuges. It has no purgative action or other known physiological effects.

THERAPEUTICS OF PUMPKIN SEED.

It is employed exclusively as an anthelmintic for the **tape-worm**, and is preferably given in the form of emulsion. 60 gm. (2 oz.) of the fresh seed are powdered in a mortar, with 240 c.c. (8 fl. oz.) of water, until the husks are loosened and an emulsion is made. The mixture is then strained, and the whole amount taken fasting. By some it is maintained, however, that the effect is better if the husks are retained in the emulsion. Sometimes the seeds are beaten into a paste with milk and white sugar. The resin, in doses of 1 gm. (15 gr.), and the expressed oil, which is bland and unirritating, in doses of 15 c.c. (4 fl. dr.), have been used as substitutes for the seeds, and are said to be equally efficient. Some practitioners are in the habit of associating the oleoresin of male fern with pumpkin seed in the treatment of tape-worm, and others of adding pomegranate to this combination.

SANTONIN.

1. **SANTONICA.**—Santonica. (Levant Wormseed.)
2. **SANTONINUM.**—Santonin. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparation.

Trochisci Santonini.—Troches of Santonin.

ACTION OF SANTONIN.

Santonin is a very efficient **vermifuge** for the *Ascaris lumbricoides*. Its *modus operandi* is not definitely understood. It has generally been supposed that it has a specific destructive action upon ascarides; but experiment outside the body has demonstrated that it is not directly fatal to these parasites, and the most satisfactory explanation of the anthelmintic action of the drug is that it renders the small intestine so disagreeable a habitat for them that they are driven down into the lower bowel, from which they are dislodged by the purgative medicine employed in connection with the santonin. On the human system santonin has distinct effects, resulting from its absorption, the most characteristic of which is a **derangement of color vision.** There is also a **discoloration of the urine** (lemon-yellow or saffron when the latter is acid, and carmine or purplish red when it is alkaline), similar to that resulting from chrysophanic acid (*see* Chrysarobin and Rhubarb). The fæces, likewise, sometimes assume a deep yellow color. Ordinarily a portion of the santonin is dissolved by the alkalies in the stomach, with which it forms soluble and absorbable santoninates, while the remainder passes into the intestine; but under special circumstances the greater part of the drug may be absorbed in the stomach and cause general intoxication of the system. Santonin always undergoes some oxidation in the tissues, and is said to be excreted in the urine and fæces in several forms, two of which have been found to be oxysantonins. Even small doses give rise to xanthopsia, or yellow vision. In this disorder white light has at first a violet hue, usually lasting but a short time, and then a greenish-yellow color, which tints the entire field of vision; and the same has occasionally been observed with amyl nitrite. The power of seeing in dim light is also stated to be lessened. These effects have been demonstrated to be peripheral, and consequently are not due to discoloration of the media of the eye. The symptoms produced by large doses of santonin are much the same in man as in other animals. Those observed in experiments on dogs have been found to be as follows: Twitching of the muscles of the head, often beginning on one side; followed by rolling of the eyes, grinding of the teeth, flexion and extension of the neck and rotation of the head from side to side, later by regular **epileptiform convulsions**, in which the animal is first thrown into opisthotonos and then into clonic spasms of the limbs and trunk. These are interrupted by intervals of repose, during which a momentary contraction of all the muscles of the body may take place. During the convulsive seizures the respiration is irregular and insufficient, and in fatal cases it fails to return after the convulsion passes off, and the animal dies of asphyxia. In man aphasia has occasionally been noted, and some mental confusion, as well as nausea and vomiting, may result from doses too small to cause convulsions. The epileptiform convulsions are believed to be due principally to stimulation of the cortex and the brief contractions in the intervals of repose to increased activity of the parts between the cerebral peduncles and the medulla. That the medullary centres are comparatively little affected seems to be shown by the fact that the respiration, interfered with during the spasms, returns to its ordinary rate and strength during the intervals. The circulation is found to be deranged only by the asphyxia, while the heart continues to beat long after the respiration has ceased. Santonin lowers the temperature, and this is attributed to its action on the central nervous system.

THERAPEUTICS OF SANTONIN.

Santonin is now almost universally used as a remedy for **round-worms.** Upon tape-worms and the *Oxyuris vermicularis* it has very little effect. In addition to its efficiency, it is especially serviceable on account of the ease with which it may be administered to children. Owing to its insolubility in water its taste is only very slightly bitter, and it may be readily given in powdered sugar or sprinkled upon bread and honey. It is generally most effective when exhibited two or three times a day until five or six doses have been taken, when a cathartic is to be administered. Lozenges containing it are not to be commended, as they may fail to dissolve. Santonin has at times been tried in amaurosis, epilepsy, suppressio mensium, and other conditions, but is now probably exclusively employed as an anthelmintic. Sodium santoninate, on account of the untoward effects to which it has been known to give rise, should not be administered.

TOXICOLOGY.

Symptoms.—A number of deaths from santonin are on record, and in a few exceptional instances serious or even fatal effects have been caused by quite small doses. The danger of poisoning is lessened if the drug is given in castor oil. In cases of poisoning by santonin, in addition to the nervous phenomena described, there are generally marked pallor and coldness of the surface, with a blue tint around the eyes or involving the whole face, dilatation of the pupils, and sweating, which is sometimes very profuse. As has been mentioned, the temperature is reduced, and there may be gastric or intestinal pain.

Treatment.—Evacuation of the stomach and bowels. Ammonia, or strychnine sulphate hypodermatically. The convulsions may be controlled by ether or chloroform.

SPIGELIA.

SPIGELIA.—Spigelia. (Pinkroot. Carolina Pink.) **Dose, 4 gm. (60 gr.).**

Preparation.

Fluidextractum Spigeliæ.—Fluidextract of Spigelia. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF SPIGELIA.

Spigelia is an efficient anthelmintic against the **round-worm,** and appears to act very much in the same way as santonin. Given in sufficient amount, it has toxic effects upon the human subject and upon animals. In the dog or cat its subcutaneous injection gives rise to retching and vomiting, muscular weakness and incoördination, hurried and dyspnœic respiration, mydriasis, and restlessness, followed by somnolence, coma and death from failure of the respiratory centre. Small quantities, given by the mouth, produce no symptoms, but large doses, especially in the case of children, may cause flushing and dryness of the skin, frequently associated with œdematous swelling of the face, and such cerebral symptoms as vertigo, dimness of vision, spasm of the facial muscles, stupor and even convulsions. Experiment has shown that toxic doses slow and weaken the heart's action and depress the motor spinal cord and the respiratory centre.

THERAPEUTICS OF SPIGELIA.

Spigelia has long been a popular and reliable remedy for lumbricoid worms. It is much less liable to give rise to symptoms of narcotic poisoning when it is given in combination with a cathartic, and senna is usually employed for this purpose. Santonin is sometimes prescribed in connection with the fluidextracts of spigelia and senna. The fluidextract of spigelia and senna, which contains a small proportion each of the oils of anise and caraway, may be given in dose of 2 to 4 c.c.; ½ to 1 fl. dr. for a child 2 years old. It is a very good preparation, and pleasant to take. The dose of spigelia, combined with a cathartic, should be repeated every four hours until a purgative effect is produced.

CHENOPOPODIUM.

Chenopodium (not official).—Chenopodium. (American Wormseed.) **Dose, 1 to 2 gm.; 15 to 30 gr.**

OLEUM CHENOPODII.—Oil of Chenopodium. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF CHENOPODIUM.

Wormseed is one of the most efficient anthelmintics, particularly against *Ascarides.* The oil acts as a stimulant to the circulation and nervous system. It is said to increase the cardiac rate and to promote the secretions of the skin, bronchi and kidneys.

THERAPEUTICS OF CHENOPODIUM.

The oil has sometimes been given in infantile colic, flatulent dyspepsia, chorea, hysteria, neurasthenia, chronic malaria, and amenorrhœa, but at the present time is used almost exclusively as an anthelmintic. For this purpose it may be given dropped on lump sugar, in capsules, or in emulsion. The dose is usually repeated three times a day, before meals, for two days, when a cathartic should be ordered. It is, no doubt, the safest vermifuge in case the mucous membrane is inflamed, as it not only causes the expulsion of the worms, but also appears to have a beneficial action upon the intestinal irritation.

C. ANTIPARASITICS.

CHRYSAROBIN.

CHRYSAROBINUM.—Chrysarobin. **Dose, 0.030 gm. = 30 milligm. (1/2 gr.).**

Preparation.

Unguentum Chrysarobini.—Chrysarobin Ointment.

ACTION OF CHRYSAROBIN.

External.—Chrysarobin has a deep and strong **local irritant action.** Applied to the skin it induces itching, redness and swelling, and in some instances follicular or furuncular dermatitis. It stains the skin and clothing a dark yellowish-brown or purple color, which may, however, be removed by a weak solution of chlorinated lime or caustic soda, provided no soap or alkali has been used. Its application to the skin has been known to cause slight albuminuria. A certain amount is absorbed from the skin, and if it is applied over an extended area it may give rise to constitutional symptoms. It is also irritant to mucous membranes. Small quantities will excite conjunctivitis, and the inflammation set up by it is sometimes so severe as to result in corneal ulceration. It is said that those engaged in collecting the drug (goa powder) often suffer from irritation of the face and eyes, with palpebral œdema. In a dilute form chrysarobin acts as a reducing agent, having the property of taking oxygen from the tissues and promoting the growth of normal epithelium. The drug is a **vegetable parasiticide,** being poisonous to organisms of a fungous type.

Internal.—Chrysarobin is a decided **gastro-intestinal irritant.** It produces copious, watery, brownish-colored stools, with repeated vomiting, but not much nausea. The greater part of it passes through the tissues unchanged; the remainder is absorbed and undergoes oxidation to chrysophanic acid. The portion absorbed is excreted in the urine, to which it imparts a yellow color, which turns to red upon the addition of alkalies. In animals it has been observed to cause severe nephritis (in which the glomeruli were less affected than the epithelium of the tubules), with albumin and sometimes blood in the urine.

THERAPEUTICS OF CHRYSAROBIN.

It is largely used locally for its stimulating action in certain chronic inflammatory diseases of the skin, and also for its curative effect upon vegetable parasitic eruptions, such as the various forms of tinea. In the former class it is of service in the treatment of eczema, acne rosacea, lupus vulgaris, and especially psoriasis, in which it is considered by many the best known external remedy. It should always be used with caution, as it is liable to set up dermatitis of the surrounding integument. It is recommended that the official ointment should be considerably diluted before application, on account of the danger of exciting too much inflammatory reaction. In many instances the best way to use it is in the form of a pigment composed of chrysarobin, 1; solution of gutta percha (made by decantation of gutta percha, 1; lead carbonate, 1; chloroform, 9), 9. This can be painted with accuracy on the parts desired, and is less liable to stain. Another cleanly manner of employing chrysarobin is by dissolving 1 part in 7 parts of chloroform, and stirring an equal quantity of soft petroleum into the mass; applying by means of a brush. Chrysarobin should rarely or never be used on the face, account of the danger of inducing œdema of the eyelids or conjunctivitis. For the same reason it should also be used with great caution on the scalp. Alopecia circumscripta and ringworm of the scalp, however, have both been very successfully treated by means of it. It is affirmed by some that the action of this drug upon certain cutaneous affections is not only local but also constitutional, the opinion being expressed that, absorbed from one part of the skin (as, for instance, one limb), it is capable of exerting a beneficial influence upon other parts of the skin (as another limb) to which it has not been directly applied. However this may be, there seems to be little question that in many of the conditions in which chrysarobin has been employed equally good results may be obtained by other remedies which are not so irritating and so liable to give rise to unpleasant effects. Excellent results have been claimed in external hæmorrhoids from the use of an ointment containing chrysarobin, iodoform and extract of belladonna, and in internal hæmorrhoids from suppositories made up with the same ingredients. It has been tried, given internally, in small, repeated doses, especially in psoriasis, but the vomiting, griping, purging, and depression resulting have necessitated its abandonment.

STAPHISAGRIA.

STAPHISAGRIA.—Staphisagria. (Stavesacre.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparation.

Fluidextractum Staphisagriæ.—Fluidextract of Staphisagria. **Dose, 0.05 c.c. (1 ♏).**

ACTION OF STAPHISAGRIA.

It is a **parasiticide** and is irritating to the skin, producing erythematous inflammation. Taken internally it is a gastro-intestinal irritant and a depressant to the motor nerves, heart and respiration, causing death by asphyxia.

THERAPEUTICS OF STAPHISAGRIA.

It is principally used in pediculosis, and may be applied in the form of ointment (Staphisagria, 4; yellow wax, 2; benzoinated lard, 17). Sometimes the dry powder is dusted over the affected surface, and sometimes the fluidextract is used in combination with diluted acetic acid. An oil has also been extracted from the seeds by ether, and it is applied in an ointment (4 c.c., 1 fl. dr., to 30 gm., 1 oz., of lard) or diluted with from 6 to 12 parts of almond or olive oil. Applications of this character are also efficient in scabies and in prurigo senilis. In using staphisagria externally care should be taken to apply it only upon the unbroken skin. A case is recorded in which its too free use upon a child was attended with fatal results.

PICROTOXIN.

Picrotoxinum (not official).—Picrotoxin. **Dose, 0.0005 to 0.001 gm.; $\frac{1}{120}$ to $\frac{1}{60}$ gr.**

ACTION OF PICROTOXIN.

External.—Picrotoxin, being very destructive to lower forms of life, is an energetic **parasiticide.**

Internal.—It is a powerful poison, causing vomiting, acceleration of respiration, slowing of the pulse and palpitation of the heart, stupor and unconsciousness, tonic spasms passing into clonic, collapse, repetition of convulsions, and asphyxia. The clonic spasms are entirely different from those produced by strychnine, and the central nervous effects of the drug are due mainly to its action on the medulla oblongata; the spinal cord and the higher parts of the brain remaining comparatively little affected. As the result of the intense stimulation of the medulla, there is clonic contraction of the muscles throughout the body. In the frog, spasm of the laryngeal muscles, by preventing the escape of air from the lungs, leads to a characteristic bloating of the animal. It has been found that picrotoxin, like other convulsive poisons, tends to lower the temperature when given in quantities insufficient to cause the spasms. In very small doses it appears to act as a **bitter tonic** to the gastro-intestinal tract, increasing secretion and promoting peristalsis.

THERAPEUTICS OF PICROTOXIN.

External.—In an ointment of the cocculus seeds in lard (1 to 6) cocculus is efficient in destroying pediculi and the *acarus scabei* and for the relief of trichophytosis, tinea versicolor, and other parasitic affections, but its use is attended with considerable danger from poisoning. Care is therefore necessary, and abraded surfaces should be avoided. As the best way of employing this remedy in the treatment of animal and vegetable parasitic affections, it is recommended that a small quantity of picrotoxin (not exceeding 1 per cent.) be prescribed in combination with mercuric oleate ointment (oleate of mercury, 1, benzoinated lard, 3).

Internal.—Picrotoxin has been advised in atonic conditions of the stomach and cases of torpor of the intestines dependent upon deficient secretion and paresis of the muscular layer. In migraine associated with the menstrual period and in nervous dysmenorrhœa it is said sometimes to afford relief if given a day or two before the flow. Some observers have found it of benefit in epilepsy, especially of the nocturnal and anæmic types and in cases attributable to onanism, while others assert that it really tends to aggravate the paroxysms. It has been tried in other nervous diseases, such as chorea, infantile convulsions, and various forms of paralysis, but the results thus far have not been such as to inspire confidence in its efficacy. There is one application of the drug, however, in which all appear to agree as to its utility, at least in many instances, namely in the treatment of the night-sweats of phthisis. It does not produce the disagreeable dryness of the skin and throat caused by atropine, and not infrequently succeeds in cases where the latter fails. It acts less promptly than that remedy, however, and it is generally necessary to repeat the dose for four nights in succession before the sweating is completely controlled. The effect thus produced then lasts for from ten to fourteen days. This action of picrotoxin has been explained by its influence in increasing the respiration, which, through the partial asphyxia caused, prevents the stimulation of the mechanism of perspiration. In order to secure the desired result more quickly it may be given three times a day. It is also useful in other forms of hyperidrosis. It is administered in tablets or pills or in solution, and to keep better it is recommended that glacial acetic acid should be added to the latter. It is also sometimes injected hypodermatically, and tablets containing .0006 gm. ($\frac{1}{100}$ gr.) each are prepared for this purpose. As it has been demonstrated by experimental research that picrotoxin is the physiological antagonist of hydrated chloral in rabbits and other animals, it would seem likely to prove of service in the treatment of poisoning by that drug. Conversely, in cases of poisoning by picrotoxin, chloral should be used, together with anæsthetics, to control the spasms. The combined administration of chloral, morphine and minimal doses of atropine has recently been recommended as the result of animal experiments.

D. ANTIPERIODICS.

CINCHONA.

1. **CINCHONA.**—Cinchona. (Peruvian Bark.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Cinchonæ.** — Fluidextract of Cinchona. **Dose, 1 c.c. (15 ♏).**

2. **Tinctura Cinchonæ.**—Tincture of Cinchona. **Dose, 4 c.c. (1 fl. dr.).**

2. **CINCHONA RUBRA.**—Red Cinchona. **Dose, 1 gm.; 15 gr.**

Preparation.

Tinctura Cinchonæ Composita.—Compound Tincture of Cinchona. **Dose, 4 c.c. (1 fl. dr.).**

3. **QUININA.**—Quinine. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Elixir Ferri, Quininæ et Strychninæ Phosphatum.**—Elixir of the Phosphates of Iron, Quinine and Strychnine. **Dose, 4 c.c. (1 fl. dr.).**

2. **Glyceritum Ferri, Quininæ et Strychninæ Phosphatum.**—Glycerite of the Phosphates of Iron, Quinine and Strychnine. **Dose, 1 c.c. (15 ♏).**

3. **Oleatum Quininæ.**—Oleate of Quinine.

4. **Syrupus Ferri, Quininæ et Strychninæ Phosphatum.**—Syrup of the Phosphates of Iron, Quinine and Strychnine. **Dose, 4 c.c. (1 fl. dr.).**

5. **Syrupus Hypophosphitum Compositus.**—Compound Syrup of Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

4. **QUININÆ SULPHAS.**—Quinine Sulphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

5. **QUININÆ BISULPHAS.**—Quinine Bisulphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

6. **QUININÆ HYDROBROMIDUM.** — Quinine Hydrobromide. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

7. **QUININÆ HYDROCHLORIDUM.** — Quinine Hydrochloride. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

8. **QUININÆ SALICYLAS.**—Quinine Salicylate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

9. **CINCHONINÆ SULPHAS.** — Cinchonine Sulphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

10. **CINCHONIDINÆ SULPHAS.**—Cinchonidine Sulphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Unofficial Preparations.

1. **Quininæ Carbamas.**—Quinine Carbamide. (Quinine Urea.) **Dose, 0.30 to 1.20 gm.; 5 to 20 gr.**
2. **Quininæ Tannas.**—Quinine Tannate. **Dose, 0.050 to 1.20 gm.; 1 to 20 gr.**

ACTION OF CINCHONA AND ITS ALKALOIDS.

Cinchona owes its effects on the organism almost entirely to the quinine in it. The bark, however, is more of a gastric irritant than quinine and is also a decided astringent, while on account of its bulk its active principles are more slowly absorbed. Large doses of it have been known to cause an apparently well-marked febrile paroxysm, beginning with chill and terminating with slight perspiration, but quinine, while its untimely use may reproduce the paroxysm with more or less severity in a malarial subject, has been found incapable of exciting such symptoms in a healthy individual. Quinine sulphate, bisulphate, hydrochloride and hydrobromide have the same action as quinine itself. The action of the drug may be most conveniently studied from the effects of quinine sulphate, which from its general use is commonly known simply as quinine.

External.—Quinine has little or no influence upon sound skin, but is distinctly irritant to mucous membranes and raw surfaces. It is recognized as a protoplasm poison, its action extending with but little variation throughout most forms of living matter, and generally consisting in a transient augmentation of activity which is followed by depression and death. Quinine solutions, therefore, have considerable **antiseptic** power, while the lactic, butyric and alcoholic fermentations, through the effects of the alkaloid on the organisms, are either retarded or completely prevented. It appears to have an elective action, however, since it has been found devoid of influence upon some of the lower forms, as, for instance, the common mould penicillium, which grows freely in its solutions. This same selective action is also observed in its effects on the ferments of the higher animals. Thus, in artificial experiments it has been found that while the gastric and pancreatic ferments are rendered less active by the addition of quinine, the drug has practically no effect on the action of ptyalin and diastase. In brief, from the results of careful experimental research it has been concluded that quinine hinders some, if not all, of the processes which normally occur in living matter and are expressed in movement and various chemical products, and also that this action is not confined to the intact protoplasm, but extends to the ferments. In regard to the amount of its antiseptic power, most observers have found this equal to or greater than that of carbolic and salicylic acids, but considerably less than the salts of mercury and silver. About 0.2 per cent. solutions are antiseptic; this strength, it is stated, preventing acetic and butyric fermentations and the decomposition of albuminous substances. Some bacilli are quite susceptible to its influence; others, especially anthrax spores and the spirillum of relapsing fever, are found more refractory.

Internal. *Alimentary Canal.*—Its chief action here is that of a **vegetable bitter.** The bitter taste is marked and prolonged. The gustatory and gastric nerves are stimulated reflexly, inducing more or less increase in the salivary and gastric secretions. It is, then, a stomachic tonic, promoting appetite and digestion. It is a question how far its antizymotic action, which if unrestrained would exert some slight retarding influence on the gastric juice, and so tend to interfere with digestion, is really operative; but it seems probable that this is more than counterbalanced by the reflex effects on the stomach and the mild stimulation of the gastric mucous membrane. In large doses it may cause nausea and vomiting. On the intestine quinine has no well-marked effects except it be given in large amount, when it acts as an irritant and may cause diarrhœa, which in exceptional instances may be characterized by bloody stools. The preparations of cinchona bark, owing to the presence of tannic acid, sometimes exercise an astringent effect upon the intestinal mucous membrane, and cause constipation. When taken into the stomach quinine is dissolved by the acid gastric juice, and quinine chloride is formed. If not promptly absorbed, however, it passes into the intestine and is liable to be precipitated by the alkaline secretions, which form with it insoluble salts; so that under these circumstances a considerable portion of the quinine escapes absorption and is discharged in the fæces.

Blood.—Quinine has been shown to have a special action upon the blood, which, however, is merely an illustration of its effects on the tissues generally.

(*a*) *White corpuscles.*—When a small quantity is added to a drop of blood on the warm stage of the microscope it is observed that the normal changes in form and position of the leucocytes are at once stopped, while these cells become spherical in shape, darker in color and granular, and shortly disintegrate into débris. Similar results are observed in the mesentery of the frog when quinine is applied locally, and if the part be slightly irritated, so as to set up inflammatory action, the leucocytes do not accumulate in the tissues, as would be the case without the application of the drug; while if the quinine is applied after such irritation has been resorted to, the outpouring of the leucocytes through the capillary walls (diapedesis) is at once arrested. The same thing occurs when quinine is injected into the circulation, and the leucocytes, which assume a spherical form, are considerably diminished in number. While, however, these changes are due, no doubt, to the poisonous action of the drug on the white corpuscles, it has been pointed out that it would be unjustifiable to infer from such experiments that quinine, in therapeutic doses, inhibits the movements of these cells in the human body. At the same time it is unquestionably true that in man ordinary quantities of quinine, even when absorbed from the gastro-intestinal tract, have the effect of diminishing the number of leucocytes.

(*b*) *Red corpuscles.*—On these it appears to have but little effect. It is true that certain observers have described an increase in size and others a destructive influence on the red corpuscles, but it has been found that this does not occur under ordinary circumstances. It should be stated, however, that one authority, as the result of observations made upon himself, arrived at the conclusion that quinine has a direct effect in increasing the number of the red corpuscles.

(*c*) *Other effects on the blood.*—Quinine has additional effects on the blood by reason of its action on processes attributable to unorganized ferments. Thus, the addition of quinine to drawn blood prevents the acid fermentation which normally takes place in it as the result of the oxidation of certain unknown substances at the expense of the oxyhæmoglobin, which it partially reduces. That quinine exercises an inhibiting influence on the oxidizing action of the blood is shown by the fact that blood to which the drug is added fails to decolorize indigo or to form the blue oxidation product of guaiac. It therefore **lessens the ozonizing power** of the blood; but although the oxidizing energy of the latter is diminished, and oxygen is given off less readily, it has been found that the hæmoglobin is apparently uninfluenced. Another action which is stated to be retarded by the presence of quinine is the coagulation of the blood.

Heart and Circulation.—On the isolated frog's heart it is found that the action of quinine, which is entirely muscular, consists in slowing of the organ and a marked diminution in the strength of its contractions. In mammals it causes at first contraction of the arterioles and a quickening of the heart's action, which are followed by dilation of the vessels and a slowing and weakening of the cardiac contractions. These effects are believed to be probably due to the direct influence of the alkaloid on the muscular structure of the circulatory system, although by some the acceleration has been attributed to depression of the inhibitory mechanism in the heart or in the medulla. Accompanying the acceleration of the pulse there is a rise of blood-pressure, which seems to depend mainly on the vaso-constriction. It has been found that the pulse-rate in general follows the blood-pressure, but that during the fall it does not sink so rapidly and markedly as the pressure. In fatal poisoning the heart is stated to be generally very much weakened when the respiration stops, but continues to beat for some time afterwards. Quinine very frequently causes **derangement of the sense of hearing** and less commonly derangement of that of sight, which are believed to be due to vascular changes, rather than to any effect upon the brain. In the one case there are deafness and ringing in the ears and in the other defective color-vision, contraction of the visual field, and in some instances temporary blindness. The disorders of hearing are attributed to congestion of the auditory canal and those of sight to a very marked contraction of the retinal vessels, which may even be obliterated; but why quinine should produce these opposite vascular effects in the eye and the ear still remains unexplained. The congestion of the membrana tympani has been known to result in inflammation which caused permanent impairment of the hearing, and the constriction of the retinal vessels may be so severe as to cause degeneration of the ganglion cells and ascending atrophy of the optic nerve.

Respiration.—In moderate doses quinine slightly stimulates the respiration, but in large ones acts as a depressant. In animals lethal amounts cause death through failure of the respiration. In exceptional instances quinine induces an asthmatic condition, characterized by a feeling of suffocation and rapid, noisy and irregular breathing.

Cerebrum.—The activity of the brain is thought to be stimulated by small doses of quinine, which even seem to exhilarate in susceptible individuals. Large doses produce a sense of heaviness and fullness, with depression, confusion of ideas, hallucinations and difficulty of speech, and, in addition, there are sometimes observed giddiness or vertigo, uncertainty of gait, and slowness of the pulse. The mental depression may deepen into melancholia or even dementia (which is generally curable); while in some instances, instead of depression there is excitement, which may amount to mania. Collapse may follow. One effect of quinine on the cerebrum is of special interest from a therapeutic point of view, and that is the diminished appreciation of pain which is caused by it. By some the blindness and deafness resulting from large doses are thought to be probably partly central in origin. From poisonous amounts of quinine administered to animals the only cerebral effects noted are said to be general depression and muscular weakness.

Spinal Cord and Nerves.—In frogs quinine, in toxic doses, causes a temporary increase of reflex excitability, which is followed by the loss of spontaneous movements and paralysis of the spinal cord, as well as arrest of respiration. In mammals small quantities are said to have the effect of stimulating the spinal cord, which is afterwards depressed. It is stated that solutions of quinine when applied locally, even in sufficient strength to cause marked abnormalities in the muscular contraction, do not lessen the irritability of the nerve trunks, and that no satisfactory proof has been offered that the alkaloid affects the peripheral ends of the motor or sensory nerves.

Muscles.—Experiment shows that the strength of the contractions may be increased as much as six times by moderate amounts of quinine, but the muscle is much more quickly fatigued than the unpoisoned muscle, so that its total work is less. As the same effect is observed in curarized muscle, it undoubtedly depends upon a direct action on the muscle-fibre. Somewhat stronger doses are found to lower the contraction from the beginning, while large quantities produce a rigor analogous to that caused by caffeine. Quinine thus acts upon muscle in the same way as upon the simpler organisms, at first augmenting its energy and then weakening it.

Uterus.—There is considerable evidence to show that quinine stimulates uterine contractions when labor has already commenced. In some cases it also appears to increase the menstrual flow, but it is improbable that it is capable of exciting abortion, as claimed by some. Its action in uterine inertia may perhaps be due in part to its action on unstriped muscle, such as it appears to have in the case of the arterioles, and in part to its effect in arousing the general nervous forces of the system. It tends to prevent post-partum hæmorrhage by causing contraction of the uterus.

Urine.—Quinine has sometimes, but not constantly, the effect of somewhat increasing the amount of urine, an action which is thought to be due to its influence upon the renal epithelium, by which it is excreted. Quinine is found in the urine within half an hour after its ingestion by the mouth, and about one-half the quantity absorbed is stated to be excreted within six hours. After this its elimination takes place less rapidly, and traces may be discovered in the urine seventy-two hours after its ingestion. Even in very small doses quinine has a pronounced effect on metabolism, or tissue change. In the excretion of nitrogen there is at first a slight increase and then a marked diminution, which, with large doses, may amount to 39 per cent. This is the result of the powerfully depressant action of quinine on the elimination of all the nitrogenous excretory principles, and especially urea and uric acid. In contrast to this, and somewhat contrary to what one would naturally be led to expect, is the slight influence of quinine upon the oxidation of the body; the quantity of oxygen absorbed and of carbon dioxide given off being practically unaffected by even large medicinal doses. While quinine is excreted chiefly through the kidneys, it appears to be diffused from the blood to a limited extent through various other channels, and has been detected in the tears, saliva, sweat and milk, as well as in the bile and in dropsical effusions.

Temperature.—In the normal subject quinine sometimes has the effect of reducing the body temperature to a small extent. In other instances the temperature remains entirely unaffected, while in still others it undergoes a slight rise. As a rule, it may be stated, small doses cause this slight rise, while doses considerably larger, but not sufficient to produce marked collapse, occasion an insignificant fall of temperature. In febrile conditions, however, it has a decided **antipyretic** effect, though not so marked as that of drugs of the antipyrine and salicylic acid classes. The fact that this action may be produced after division of the spinal cord shows that it does not depend upon any influence exerted upon the central nervous system, and it is now generally accepted that the temperature-reducing property of quinine is due to the direct action of the alkaloid upon the tissues. It is true that the excretion of carbon dioxide is generally regarded as an index of chemical changes resulting in the liberation of energy and consequently of heat; but, while, as has been seen, quinine ordinarily does not seem to affect this to any appreciable extent, it is thought extremely probable that the antipyretic action of the drug is due to its retarding the metabolism. In support of this hypothesis it has been suggested that the presence of fever poisons throws the tissues into a state of augmented activity, in which they are more susceptible to the sedative action of the drug, and that even in the normal organism a reduction of the temperature might be induced if a sufficient quantity could be taken without exciting other symptoms. In this connection attention is called to the fact that in fever the nitrogenous decomposition is much increased, while quinine has a directly opposite effect; and it is pointed out that the diminution in the nitrogenous metabolism may also lead to an increased resistance being offered to the cause of the fever, or may lessen the poisonous products circulating in the blood. Furthermore, it is argued, the bacteria causing fever may themselves be rendered less active by the alkaloid, although this antiseptic action is probably of subordinate importance, since many of the pathogenic forms have been found to offer great resistance to it. Other authorities hold, somewhat in the same line, that as it is an indubitable fact that the production of heat is diminished by quinine in fever, we are forced to the conclusion that oxidation or combustion (as shown by the excretion of carbon dioxide) is not the only source of heat; that heat may also be liberated by other changes—by the splitting or hydration of nitrogenous molecules, in the course of which the nitrogen is converted into urea; and that these changes are those which are hindered by quinine. If then it be supposed that this form of heat production is, as seems probable, especially prominent in fever, the fact that quinine acts on febrile, and not on normal temperature, would also be explained.

Cinchonism is the name given to the train of symptoms to which doses of .60 gm. (10 gr.), or more, of quinine are liable to give rise. The most characteristic of these are a sense of fullness in the head, tinnitus aurium, and slight deafness. From larger amounts these symptoms may be augmented, and in addition the patient may suffer from disorders of vision, sometimes amounting to blindness, and the severe cerebral disturbances which have already been mentioned. The susceptibility to the physiological effects of the drug differs very greatly in different individuals, and various idiosyncrasies as regards its influence have frequently been noted. Occasionally it is the cause of cutaneous eruptions, such as erythema, urticaria, herpes, purpura, etc., and instances have even been reported in which the affection was gangrenous. A peculiar rash has also been observed among workers in cinchona bark. A case has been recorded in which .004 ($\frac{1}{16}$ gr.) of quinine repeatedly produced an erythematous or bullous eruption, and .20 gm. (3 gr.) has been known to be followed by severe constitutional disturbance, hæmatemesis and bloody stools. Gastro-intestinal irritation is not infrequently occasioned by comparatively small doses, and in a very few instances albuminuria and hæmaturia have resulted from it. Death from quinine is of extremely rare occurrence. Enormous doses have sometimes been taken without peril to life, and it seems probable that in these cases a large proportion of the drug passed through the system without being absorbed. Hydrobromic acid has been found in many instances to prevent the ringing in the ears or headache caused by it, and from 2 to 7.5 c.c. (½ to 2 fl. dr.) of the diluted acid may be given with ordinary doses of quinine. The bromides may also be used for this purpose, and ergotin likewise is said to diminish the liability to cinchonism. In respect to their effects on the brain, morphine and quinine are regarded as antagonistic, and in respect to their action on the sympathetic system, on the heart, and on the temperature, quinine and atropine. The latter drug is said to be successful in combating the annoying cutaneous effects sometimes caused by quinine.

Relative Action of the Alkaloids.—The other alkaloids resemble quinine very closely in their effects on the system, but are weaker in their action. Quinidine is most like quinine, while cinchonine and cinchonidine differ from the latter in having a convulsant influence; in consequence of which the stage of stimulation in their action on the central nervous system is more marked. This tendency to produce convulsions, which are of an epileptiform character, is said to be much the more pronounced in the case of cinchonidine, which, but for its resemblance in other features to quinine, might, it is held, be classed among the convulsive poisons. The relative antipyretic effect of the alkaloids has been set down as follows: Quinine, 100; quinidine, 90; cinchonidine, 70; cinchonine, 40.

THERAPEUTICS OF CINCHONA AND ITS ALKALOIDS.

External.—The expense of quinine renders it unavailable, as a rule, for antiseptic purposes. A one per cent. solution of quinine sulphate is sometimes used, however, as an application to unhealthy sores and infected wounds, and a five per cent. solution as a wash in diphtheria, an injection in otorrhœa, hay-fever, gonorrhœa and chronic cystitis, and an insufflation in whooping-cough. An attack of hay-fever, if the catarrhal irritation is confined to the nares and fauces, may in some instances be arrested by the topical application by means of a camel's-hair brush, or in the form of a spray, of a solution of quinine hydrochloride (.25 to .50 gm., 4 to 8 gr., to 30 c.c., 1 fl. oz., of water). Powdered quinine sulphate, dusted upon chancroids, is said to promote rapid healing.

Internal.—*Gastro-intestinal Tract.*—The preparations of cinchona are used to a large extent in digestive troubles, especially when associated with a debilitated state of the system, and, if their administration is not maintained for too long a time, generally serve an excellent purpose. In conditions such as atonic dyspepsia and gastric catarrh they may often be combined advantageously with the mineral acids. They are contra-indicated in all inflammatory states of the gastro-intestinal mucous membrane, but where the latter is relaxed and there is more or less diarrhœa without inflammation, preparations of the red bark are likely to be of great benefit. In many cases the compound tincture, which contains other stomachics also, is to be commended. (The name of "Huxham's tincture" is often applied, incorrectly, to this preparation.) In the gastric catarrh of drunkards the alkaloid quinine, generally combined with acids, is considered of special service. Quinine is one of the most commonly used of all tonics, and in the small quantities required for this purpose may generally be continued for a very considerable time without causing any impairment of digestion or absorption. It is frequently given associated with iron, and is apt to be prescribed especially with the tincture of ferric chloride, the free acid in which readily dissolves it. Strychnine is also often added to combinations of quinine and iron, as in the official elixir, glycerite and syrup. The tonic dose of quinine sulphate or hydrochloride is from .03 to .12 gm. (½ to 2 gr.), and the latter salt is not infrequently preferred to the sulphate on account of its greater solubility.

Antipyretic Effect.—While quinine was formerly much in vogue as an antipyretic, at the present time, except in the case of malarial fever, it is seldom employed in this capacity, since in the comparatively rare instances where it is deemed advisable to reduce the temperature by means of drugs this can be much more certainly and efficiently accomplished by the coal-tar derivatives, such as antipyrine, acetphenetidin and acetanilide. Where for any reason it is desirable to use quinine in febrile conditions for this purpose it should be given preferably in a single dose of from 1.20 to 2.40 gm. (20 to 40 gr.) for an adult. It may be administered in tablets or capsules, suspended in milk, or in solution. For dissolving the hydrochloride only water, in sufficient quantity, is required, but in the case of the sulphate it may be necessary to add acid. With these large doses it is advisable to give sodium or potassium bromide, in order to avoid the disagreeable tinnitus which is likely to be set up by the drug. The diluted hydrobromic acid is an excellent solvent, and, at the same time, will relieve the ringing in the ears. In a considerable proportion of cases the antipyretic action of quinine may be relied upon, and, like the other antipyretics, it will be found most efficient at a time when the temperature has a natural tendency to fall. Usually about two hours elapse before the antipyretic effect manifests itself, and it should therefore be given at that interval before an expected decline in temperature. Quinine, it is worth noting, possesses the advantages over the coal-tar antipyretics of a more prolonged action and of exposing the patient to much less risk of collapse. It is therefore still prescribed to some extent in surgical fever.

Specific Action.—One of the most positive effects in the whole range of Medicine is that of quinine, and to a less pronounced degree the other alkaloids of cinchona, in arresting the paroxysms of malarial fever. It is now known that this result is due to the **directly poisonous action** of the drug **upon the plasmodium malariæ,** which infests the blood and is the specific cause of the disease. Outside the body a 1 to 10,000 solution of quinine will immediately arrest the movements of the hæmatozoön, and the same thing is found to occur when the alkaloid is circulating in the blood. Here it prevents the entrance of the spores into the red-corpuscles, in which their cycle of development solely takes place. About three hours after the administration of quinine by the mouth it is stated that the endoglobular forms met with in tertian and quartan fever become immobile and granular, and lose their affinity for certain stains; while several hours later they may be seen deformed and segmented. Experimental research has shown that quinine does not act equally on the parasite in all its stages; its most powerful effect being upon the forms which are just breaking into spores and upon the free-swimming organisms, while its action is much weaker upon the older segmenting bodies, and least upon the young endoglobular forms. Since it has been found that these last exist in the blood just before the paroxysm, their sporulation giving rise to the characteristic chill with its ensuing febrile reaction, quinine, on account of the inefficiency of its action upon them, will have little or no effect in counteracting the paroxysm then impending. If, however, it is given at this time it will, it is argued, be present in the blood when the spores are liberated, and as these, as has been seen, are most susceptible to its action, it will be able (if the quantity administered has been sufficiently large) to destroy them, and thus prevent the development of the new cycle. It is advisable, therefore, that the alkaloid should be given several hours before the expected paroxysm, so as to allow time for absorption. The powerful destructive action which quinine exerts on the malarial parasite, both in and outside the body, is exactly the same as that which is observed in the case of amœbæ and other similar forms. It is explained by the effects of the alkaloid as a protoplasmic poison, by virtue of which it acts more strongly (specifically) on the lower forms of life than on the higher, and hence can be introduced into the human body with perfect safety in quantities which are sufficient to destroy such simple organisms. In addition to this direct action, it is held by some that quinine has an indirect action, manifesting itself in an alteration of the environment, in consequence of which the latter is rendered less favorable to the growth of the parasite. As an example of this is cited the diminished readiness with which the red blood-corpuscles part with their oxygen after the addition of quinine. Both theory and experience, it has been observed, point to the decline of the fever as the most advantageous time for the administration of the drug. Some prefer to give a single large dose (usually about 1 gm.; 15 gr.), and others divided doses, of about .30 gm. (5 gr.), at intervals between the attacks. Since the elimination of quinine takes place with considerable rapidity, the maximum curative effect is believed to be obtained by the administration of the whole amount required in one dose, rather than by a succession of small doses. As the result of a very extended observation one of the best authorities on this subject states that according to his experience the most effective method of treating an intermittent is to give a full dose of quinine (.60 gm.; 10 gr.) in the sweating stage, and the same quantity five hours before the time of the next paroxysm. He has also found that the anti-periodic property of quinine is increased, while the cerebral effects of large doses are diminished, by combination with morphine. If in any case a very prompt effect is desired, from 1 to 2 gm. (15 to 30 gr.) of quinine carbamide (not official), which is very soluble, may be administered hypodermatically; a smaller dose, .30 to .50 gm. (5 to 8 gr.) in an hour or two, is almost invariably successful in preventing the next immediate chill. After the paroxysms have been overcome the remedy should not be entirely abandoned, but, for at least three weeks, on the seventh day from the date when the last one appeared full cinchonism should be produced, by the use of from .60 to 1 gm. (10 to 15 gr.) of quinine; as the attacks show a decided tendency to recur in cycles of seven days. It has been found that the action of quinine is materially assisted by the continuous administration of arsenic during the intermissions, and until the third septenary period has passed. Quinine is both curative and prophylactic, and it has in numberless instances been proved that its regular administration in very moderate quantities (from .20 to .30 gm.; 3 to 5 gr. a day) will absolutely or to a large degree protect persons living in malarious regions from ague. If the malarial poison is active, and the conditions are otherwise unfavorable, the amount should be doubled; and it is to be noted that an enormous experience has now shown that the drug when taken thus as a prophylactic is entirely free from injurious effects. In remittent fever the best plan of administration is to give from 1.20 to 2 gm. (20 to 30 gr.) of quinine in a single dose once or twice each day until the temperature is reduced to normal. In the pernicious variety of malarial fever the patient's life is in imminent danger, and not only are large doses of quinine, from 1.20 to 3.60 gm. (20 to 60 gr.) demanded, but they must be given promptly; so that administration by the stomach, rectum and hypodermatic injection may be in turn or simultaneously practiced. In any severe attack of ague Clark's powder, which consists of quinine, 10; powdered capsicum, 4; powdered opium, 1 part, may be resorted to. This is usually given in 1.00 gm. (15 gr.) doses, and is said to be more efficacious in the treatment of the disorder than larger doses of quinine when given alone. In chronic malarial infection quinine is less curative than in the acute; the principal reason for this probably being the presence of certain structural alterations resulting therefrom in the liver, spleen, kidneys, intestines or central nervous system. Here quinine and the salicylates together are more effective, and they may often be combined advantageously, according to circumstances, with iron, arsenic or cholagogue cathartics such as the preparations of podophyllum. When an individual has once suffered from malaria any subsequent affection which he has is apt to assume a malarial type. This is especially true of neuralgia, which is often located in the forehead and has received the name of "brow-ague." It generally yields promptly to quinine, which is also sometimes of service in neuralgias not of malarial origin. Not only superficial neuralgias in various portions of the body, but also neuralgic pains in any of the deep-seated organs, may be an expression of the malarial cachexia as affecting the sensory nervous system; while its influence on the motor apparatus may be shown by such disorders as chorea, epilepsy, asthma, hiccough, laryngismus stridulus, and spasmodic stricture of the urethra. These neuroses, it has been found, may either be substituted for the ordinary malarial paroxysm (chill, fever and sweating) or may assume a periodical character in consequence of having occurred in a system already affected with malaria. They are to be distinguished from other functional nervous affections by the more uniform periodicity in the recurrence of the paroxysms, and if the patient is known to have previously suffered from malarial infection the diagnosis is usually simple. In the case of malarial neuralgias particularly, morphine is of material service as an adjunct to the action of quinine. Malarial diarrhœa, dysentery and jaundice may sometimes be promptly relieved by quinine, but if these depend on structural alterations in the liver or the intestinal glands they are naturally more intractable. Hæmaturia of malarial origin usually requires large doses of the remedy. *Warburg's tincture* is a remedy which has long enjoyed a considerable reputation in the treatment of malarial infection, especially in the tropics. It contains quinine sulphate, 80; Socatrine aloes, 100; opium, 1; rhubarb, 32; camphor, 8; with a number of aromatics and menstruum to 4000. The proportion of quinine is about .60 gm. (10 gr.) to 30 c.c. (1 fl. oz.) of menstruum, and the dose is 4 to 15 c.c. (1 to 4 fl. dr.). It may now be obtained in tablets, each of which represents 4 c.c. (1 fl. dr.) of the preparation. In many instances Warburg's tincture is prescribed without the aloes. In enlarged spleen (ague-cake) and in conditions, such as malarial jaundice, where there is great irritability of the stomach or of the intestinal mucous membrane, as well as in all cases where it becomes necessary to secure the promptest possible effect, it is advisable that quinine should be administered subcutaneously. The simple alkaloid and quinine sulphate are not adapted for this purpose, as they produce too much irritation, and have even been known to give rise to tetanus; and hence it is requisite to use some more soluble preparation of quinine, such as quinine carbamide (quinine urea).

Other Uses.—Quinine has been employed in a great variety of conditions besides those already mentioned, and in many of them with good results. There is no question of its distinct value in the treatment of whooping-cough, which there is good reason to suppose is a microbic disease. In order to get the full benefit of its remedial agency, however, it should be slowly swallowed in solution, so that it may act locally on the mucous membrane of the fauces as well as produce an internal effect; and given in this way its intensely bitter taste proves an almost insuperable objection, as it is extremely difficult to get children to take it. Still, in other forms it has been found of considerable service by a number of observers. It may therefore be given in capsules or combined with chocolate or administered by the rectum in suppositories or enemata. It is advised that in the case of an infant under one year the treatment should be commenced with as many centigrammes as its age in months, and that older children should take daily as many decigrammes as their age in years. In no case, however, should the amount taken in a single day exceed 1.5 gm. (23 gr.). To children the tannate (not official) is not infrequently given, as it is practically tasteless, and made into tablets with chocolate is readily taken. As it contains much less quinine, the dose should be twice as large as the sulphate. In influenza, quinine, either alone or combined with other remedies, has been used with some success, and it is also claimed that it is of value as a prophylactic in this disease. When an attack has commenced it is said that its early administration tends to prevent or diminish cardiac complications, as well as other complications and sequelæ. In certain cerebral affections it is of decided benefit. In the case of elderly people it improves the intra-cranial circulation, and so relieves a group of symptoms depending on sluggishness of the latter which has been described as follows: Headache, vertigo, failure of memory and despondency, associated with a slow pulse, an atheromatous degeneration of the vessels, puffiness of the eyelids, and dilatation of the superficial veins of the head. In the adynamic form of delirium tremens small doses of quinine are of service in tranquilizing the patient, and in the preliminary stage of the affection known as "the horrors" has been found useful, especially when combined with a mineral acid, by correcting the digestion and invigorating the cerebral motor centres. In some forms of insanity, and particularly the puerperal variety, where there is much weakness and the surface is cold and clammy, quinine is also likely to prove beneficial. In headache and in neuralgias in various localities, as well as in chorea and epilepsy, which are not dependent upon a malarial cachexia it may prove useful, provided that anæmia is present and lies at the seat of the nervous derangement; but not otherwise. The laryngismus stridulus to which rachitic children are subject is said to be ameliorated especially by quinine hydrobromide. As an adjuvant to other treatment, quinine is of value in adynamic diseases, such as diphtheria, and in surgical affections, where it aids in sustaining the vital powers and tends to check the formation of pus; as well as in cutaneous diseases like erysipelas, erythema nodosum, ecthyma and impetigo, where there is an enfeebled condition of the system. A coryza may often be successfully aborted by the administration of .60 gm. (10 gr.) of quinine with .015 gm. (¼ gr.), or less, of morphine at the onset of the attack. Quinine has also been found of service in asthma and hay-fever after the subsidence of the acute symptoms, in chronic bronchitis with bronchorrhœa, and in the night-sweats of pulmonary tuberculosis. For the latter, doses of from .90 to 1.20 gm. (15 to 20 gr.) are required. A full dose is frequently given previous to the passage of the catheter or urethral sound, in order to prevent the occurrence of a chill. Quinine is found useful by obstetricians in promoting uterine contractions after labor has once commenced, and is also thought to materially reduce the danger from sepsis. As an emmenagogue in anæmic subjects it is often combined with iron, and iron and quinine citrate is a good preparation for this purpose. There are certain classes of cases in which quinine should, if possible, be avoided. Among these may be mentioned: Idiosyncrasy, in consequence of which quite small doses produce very severe cinchonism, acute or subacute disease of the middle ear, gastro-intestinal irritation, meningitis, and inflammation of the genito-urinary tract.

DIVISION II.—DRUGS ACTING ON THE BLOOD.

A. Drugs Acting on the Plasma.—Substances of various kinds are capable, after absorption, of existing in solution in the plasma, and those which act as purgatives, diuretics and diaphoretics must necessarily alter the composition of the plasma by abstracting substances from it. The object for which drugs are given to act on the plasma is to increase its alkalinity. Were it even desirable to render it acid, no agent is at present known which is able to accomplish this, or even to reduce to any extent the natural alkalinity of the plasma. The mineral acids, as is well known, can exist in it only in the form of neutral salts.

The alkalizers of the plasma are salts of—

(1) **Potassium.**
(2) **Sodium.**
(3) **Ammonium.**
(4) **Lithium.**
(5) **Magnesium.**
(6) **Calcium.**

This is approximately the order of their alkalizing power, potassium being undoubtedly the most powerful, while calcium is very feeble.

It has been found that in the plasma the decomposition of the citrates and tartrates of these metals into alkaline carbonates takes place, and one of the purposes for which alkalies are administered is to cause, if possible, the formation of soluble urates by their combination with uric acid. Furthermore, the excretion of the urates is promoted by the diuretic action of the alkalies.

Therapeutics.—Alkalies are consequently very largely employed in the treatment of gouty conditions, which are characterized by an excess of uric acid or an analogous substance in the plasma. Lithium preparations have been regarded by many as especially beneficial in such cases, but there is no reason to suppose that this is a fact, particularly as the solubility of the urates is not increased by lithium. What is important is that the preparation selected should be one that is not apt to disturb the digestion, since the remedy must usually be continued for a considerable period; hence potassium citrate and lithium citrate are favorite salts, and the numerous natural alkaline waters are also very largely used. No doubt, one of the chief services which the latter render is the flushing of the system with a large amount of fluid.

On the hypothesis that acute articular rheumatism is due to a *materies morbi* of the plasma (by some believed to be lactic acid), which is generated within the body, large doses of the alkalies were long given in this and other affections involving a so-called rheumatic diathesis, with the idea of neutralizing and eliminating such morbid principle from the blood. This treatment, however, has now been practically supplanted by the use of salicylic acid and its compounds.

In chronic lead poisoning potassium iodide has been and is still almost universally employed. It has been supposed to promote the elimination by the kidneys of the lead, which accumulates in the tissues in a very sparingly soluble form, though it has now been denied that this salt has any effect on its excretion either by the urine or the intestine, by which most of the lead is known to make its escape from the body.

Purgatives, diaphoretics and **diuretics** necessarily have the effect of altering the composition of the plasma, and hence are frequently employed in the treatment of local or general œdema and of effusion into serous cavities, for the purpose of draining off fluid from the plasma. They are also used to facilitate the excretion of poisons from the blood in conditions such as uræmia and cholæmia. Venesection, transfusion and the intravenous injection of watery solutions naturally alter the composition of the plasma directly.

B. Drugs Acting on the Red Corpuscles.—The most important are those which are capable of increasing the amount of hæmoglobin. It is a fact, however, that there are no known drugs which will increase the amount of iron in perfectly healthy blood; hence, in a strict sense, the action of all such agents much be regarded rather as a pathological than a physiological one. These drugs are called **Hæmatinics.**

They are—

(1) **Iron and its salts.**
(2) **Arsenic trioxide.**
(3) **Potassium permanganate** (doubtful).
(4) **Hydrochloric acid**
(5) **Copper salts**
(6) **Potassium salts**
(7) **Phosphorus**
(doubtful).

They increase the quantity of hæmoglobin in each red corpuscle, as well as the number of these corpuscles. Their effects are materially assisted by all measures which tend to improve the digestion and the general health. The mode of action of these hæmatinics is still obscure, and will be discussed under each drug. Iron is by far the most important and efficient.

Indirect hæmatinics are drugs which are of service by removing some obvious cause for a deficiency of hæmoglobin (the condition known as anæmia), such as mercury, given for syphilis, quinine, for ague, etc.

Alcohol and quinine slightly diminish the oxygenating power of the blood by increasing the stability of the oxyhæmoglobin. Citrates and tartrates of the alkaline metals are partially oxidized to carbonates at the expense of the oxygen of the red blood-corpuscles.

The red blood-corpuscles are believed to be increased in size by oxygen and hydrocyanic acid, and to be rendered smaller by morphine and carbon dioxide, as well as by quinine, when, with a high temperature, as is probably the case, they are a little larger than normal. By small doses of mercury they are said to be increased in number.

In consequence of the presence of a large amount of sodium chloride, the red corpuscles pass rapidly through the walls of the capillaries.

Quinine and hydrocyanic acid diminish the ozonizing power of the blood.

Certain drugs destroy life by **altering the composition of the hæmoglobin,** and so preventing it from uniting with oxygen. Whatever their therapeutic effects, they are therefore of considerable importance from a physiological and toxicological point of view. Thus, carbon dioxide expels the oxygen from oxyhæmoglobin; hydrocyanic acid forms cyano-hæmoglobin; potassium chlorate, the nitrites, especially amyl nitrite, and most of the antipyretics (antipyrine and its compounds excepted) convert the hæmoglobin into methæmoglobin; acetanilide, amyl nitrite, potassium chlorate and pyrogallic acid destroy the red corpuscles.

Phosphorus, arsenic, hydrogen sulphide, turpentine, iodine, and sulphur also reduce oxyhæmoglobin.

Hydrocyanic acid, alcohol, chloroform, quinine, morphine, nicotine, strychnine and brucine have the effect of diminishing the oxidation of freshly drawn blood which is exposed to the air.

C. Drugs Acting on the White Corpuscles.—Normally the white corpuscles undergo constant changes of form and position exactly similar to those of the amœba, and it is found that generally those drugs which are poisons to the amœbæ are, when applied in sufficient concentration (which is rarely the case in the human body), toxic to the leucocytes. All irritants which set up inflammatory action have the effect of causing the passage of white corpuscles through the capillary walls; while all the **cinchona alkaloids,** and especially quinine, have the property of arresting this migration. **Berberine sulphate and acetanilide** act in a similar way.

Veratrine destroys white corpuscles when applied to them outside the body.

Camphor, myrrh and other aromatics are said to increase their production by increasing absorption from the intestine, while quinine, it is believed, diminishes their number in the blood.

A few other facts relative to the action of certain drugs upon the blood may be noted. Poisonous doses of mercury increase the fluidity of the blood, impair its coagulability, and diminish its solids. Phosphorus may also prevent the blood from clotting as readily as usual, and sometimes may cause it to remain fluid for forty-eight hours or more, but this is thought to be probably secondary to changes produced in the intestine and liver, rather than a direct effect of the poison. Various astringents and calcium salts (especially the chloride), on the other hand, promote coagulation. Cod liver oil increases the solids of the blood.

A. Drugs Acting on the Plasma.

POTASSIUM.

1. **POTASSII HYDROXIDUM.**—Potassium Hydroxide. (Caustic Potash.)

Preparations.

Liquor Potassii Hydroxidi.—Solution of Potassium Hydroxide. (Solution of Potassa.) **Dose, 1 c.c. (15 ♏).**

Liquor Cresolis Compositus.—Compound Solution of Cresol.

Unofficial Preparation.

Potassa Cum Calce.—Potassa with Lime. (Vienna Caustic. Vienna Paste.)

Action of Potassium Hydroxide.

In the hydroxides and carbonates of the alkalies the action of their basic metallic constituents is now known to be of little practical importance, the alkalinity of the substance mainly determining its pharmacological effects. The metallic ion serves for the most part as merely the means of applying the non-metallic constituent. It is incorrect, therefore, to regard potassium hydroxide as typifying the action of potassium on the system. The influence of the potassium ion is much more evident in other salts, and notably the chloride, in which the Cl-ion is quite inactive, while the K-ion is the energetic constituent.

Action of Potassium Salts in General.—In the salts of the latter character it is seen that potassium has a distinctly toxic action, the principal effects of which are **depression** of the **central nervous system** and of the **heart.** That the heart is injuriously affected by the potassium salts in large amount is shown by the pulse becoming much slower and weaker and by a sudden fall of arterial pressure. In animals, when these salts are injected into the circulation, the cause of death is cardiac failure. But while in cases of poisoning by quantities far in excess of therapeutic doses the special toxic action of potassium upon the heart may, no doubt, have an important share in bringing about the fatal result, the effects noted are in many instances believed to be due to the action of the poison upon the alimentary canal. Upon the brain and the motor and sensory nerves, and upon the spinal cord especially, as well as upon the heart and the muscles in general, potassium salts exert a pronounced depressant influence. In poisoning by them in the frog the central action is shown by the spontaneous movements becoming weak and slowly performed, while in mammals the chief nervous symptoms are great muscular weakness and apathy. The respiration, it is stated, becomes rapid and labored, probably from the anæmia of the centres, and death in often preceded by weak and asphyxial convulsions.

It is a fact, however, that when administered in ordinary medicinal doses these salts are not at any time present in the blood (owing to the rapidity of excretion) in sufficient quantities to produce marked toxic effects, such as are observed when they are injected directly into the circulation of animals. Their poisonous action upon the heart has given rise to exaggerated apprehensions of the danger of using them in therapeutics, and it should therefore be borne in mind that only very large quantities have any effect at all upon the heart, especially when given by the mouth. In this connection it has been pointed out that very much larger quantities of potash are taken daily in the food by thousands of persons than are ever prescribed in medicine, the amount of it in the food of some classes being estimated at from 50 to 100 gm. (1½ to 3 oz.) per day. Still, the possibility of causing undesirable cardiac depression when potassium salts are given in large and long-continued doses should lead to a certain amount of caution in their use, and especially in the case of persons suffering from cardiac disease. It is also well to remember that when administered in considerable quantity for an extended period they are likely, as has been found, to have the effect of dissolving out the hæmatin from the red corpuscles, and so produce a dyscrasia, with impoverishment and excessive fluidity of the blood.

External.—In concentrated form potassium hydroxide has a **powerful irritant and caustic action,** partly in consequence of its combining with the water of the part to which it is applied. In addition, it combines with the tissue elements to form alkaline albuminates, and with the fats to form soaps. In this way it dissolves the skin and produces necrosis of the deeper tissues. The surface generally becomes coated with a semi-transparent crust, and this eschar is subsequently separated by inflammation from the uninjured parts, leaving an ulcer. As potash forms soluble compounds with the proteids, it is only slowly neutralized by the tissues, so that it penetrates more readily than many other corrosives. In weak solution it thoroughly cleanses the skin by dissolving the superficial layer of the *stratum corneum* and the oily secretions of the glands, but if applied for some time it penetrates more deeply and may excite slight irritation and redness. On the mucous membranes it effects solution of mucus. Very dilute solutions apparently have a sedative effect; strong solutions destroy all living tissues with which they come in contact.

Internal. *Alimentary Tract. Mouth.*—It has the characteristic alkaline taste of the hydroxides and carbonates. In very weak solution it simply causes a reflex flow of saliva. In more concentrated form it dissolves the mucous secretions and the superficial layers of the lining membrane, the irritation changing to a bright red the lips, tongue and general surface of the oral cavity, which feel soapy to the touch. Still stronger solutions have, as on the skin, a powerful escharotic effect, which extends to the throat and œsophagus, and may either prove immediately fatal or give rise to subsequent cicatrization and stenosis. The accidental swallowing of caustic alkalies is probably the most frequent cause of cicatricial stricture of the œsophagus.

Stomach.—As in the œsophagus, concentrated solutions produce an amount of corrosion sufficient to destroy life in a short time, or which may be followed subsequently by gastric ulcer or scar-formation. They may prove immediately fatal by causing perforation into the peritoneal cavity. Small quantities of the drug appear to be soon neutralized by the hydrochloric acid of the gastric juice, and act no longer from their alkalinity, but merely from their effects as a salt, if at all. Larger quantities render the contents of the stomach neutral or alkaline, diminish the activity of the pepsin, and tend to prevent gastric digestion. It has been demonstrated that the alkalies have no effect whatever on the activity of the secretory glands of the stomach, while, on the other hand, they may affect the juice already secreted by making it neutral, or even alkaline, and thus completely interfere with its usefulness. In hyperacidity of the stomach, however, they may prove of benefit by lessening the amount of free acid present.

Intestines.—It is thought to be absorbed in combination with proteids or as a carbonate, and disappears rapidly from both the stomach and small intestine. In the latter it is found to have an indirect effect, in consequence of its diminishing the acidity of the gastric juice. Hence the secretion of the pancreas, which is normally stimulated by the acid fluid passing from the pylorus, is materially lessened. While, however, this again may render digestion less complete, the greater alkalinity of the intestinal contents no doubt tends to increase the efficiency of the pancreatic juice already secreted. Contrary to what was formerly believed, it has been conclusively shown that alkaline salts do not increase the secretion of bile, are not excreted in it, and do not cause any change in its reaction. It is therefore inferred that any effect which these may exert in affections of the liver are due to their effects in the duodenum. In therapeutic doses they apparently have no effect on intestinal putrefaction, but it is stated that very large quantities (15 gm.; ½ oz.) increase the putrefaction, in consequence probably of their neutralizing the disinfectant gastric juice.

Blood.—It is believed to exist in the blood chiefly as the carbonate. The alkalinity of that fluid, like that of the body in general, is increased; but the organism rapidly frees itself from the excess of alkali by excreting alkaline salts. It is stated that the blood of rabbits treated with alkalies is more strongly germicidal than usual, and that under these circumstances the animals show an increased resistance to infection with anthrax bacilli.

Respiratory Passages.—The bronchial secretion appears to be increased in quantity and also rendered less viscid. Mucin is more soluble in alkaline media, so that the alkalies dissolve any accumulations of mucus or make them more fluid.

Nervous System.—Among the effects, in addition to those of its corrosive action in the alimentary tract, which caustic potash causes from the destruction of the tissues with which it comes in contact, the **reflex influence** on the central nervous system is of great importance. In consequence of this, when the dose is large, shock may appear so rapidly and be of such violence as to completely overshadow the local symptoms, and death may occur from cardiac paralysis before these have had time to develop.

Urine.—The secretion of **urine is increased**, partly in consequence of the salt-action and partly, apparently, as the result of an irritant effect upon the renal epithelium. The absolute amount of all salts excreted is increased, although their percentage is naturally lessened. The urine is temporarily rendered less acid or even alkaline. It generally soon regains its acidity, but under the use of repeated doses of sufficient amount its reaction may be kept alkaline indefinitely. Excretion takes place chiefly by the urine.

Metabolism.—In view of the fact that outside the body certain substances undergo oxidation much sooner in alkaline solution than when neutral, and also on account of the importance, as regards their functions, of the alkaline reaction of the tissues, it might be expected that an increase in the alkalinity of the fluids of the body would have the effect of increasing oxidation and promoting the general metabolism. There is, however, no direct evidence that this is the case, and it is now recognized that the alkalies have less influence upon tissue-change than was formerly believed. The change in reaction, it is pointed out, can only be very brief, and is apparently not marked enough, or not of such a nature, as to be capable of demonstration by methods at present available. According to the observation of the best authorities the excretion of urea is sometimes increased and sometimes diminished, the explanation of this probably being that the local action of the alkali on the alimentary tract sometimes causes an increased formation and destruction of the white corpuscles of the blood, and thus increases the uric acid. Some of the most reliable observers have found that very large doses decrease the amount of the latter in the urine, while smaller ones have no effect on it. As regards the oxidation in the tissues, it is concluded that the amount of tissue waste is but little affected by the increased alkalinity of the blood, and that the slight changes observed may vary not only in different species, but in different persons, and even in the same person at different times. The cause of this individual variation is attributed either to difference in the amount of acid formed in the tissues or to differences in the local effect of the alkalies in the alimentary tract.

THERAPEUTICS OF POTASSIUM HYDROXIDE.

External.—Caustic potash was formerly employed to make issues. It is sometimes used in the destruction of lupus carcinomatous growths, etc., but its effects are somewhat difficult to limit, and great care should be taken in its application. On account of the thorough and penetrating character of its escharotic action it is to be preferred when a very deep and decided influence is desired, as after the bite of a venomous snake or rabid dog. For cauterizing morbid or cicatricial tissue it is often best to employ it in the form of Potassa cum Calce, which is milder in its operation and more manageable than pure potassa. In using it it is generally first reduced to a paste with a little alcohol, its action being limited laterally by means of adhesive plaster and in depth by the duration of the application. After the withdrawal of the caustic, diluted vinegar may be applied in order to neutralize any alkali that may remain, and this is sometimes followed by a poultice. It is often of service in phagedæna. Caustic potash is employed after operations for the cure of fistula, for the purpose of preventing immediate union. It also proves a very satisfactory agent in the treatment of ingrowing toe-nail. The portion of nail to be removed is painted with a 40 per cent. solution of it, with the effect of rapidly softening its upper layer to such an extent that it can be readily scraped off. This procedure is repeated until the nail which remains is only a thin scale, which can be excised with fine scissors. Liquor Potassii Hydroxidi may be employed to dissolve oily secretions and thoroughly cleanse the skin before operations, and, diluted, is sometimes used to remove the epidermis in some forms of chronic cutaneous disease. In like manner it softens callosities, such as corns and bunions, resulting from the effects of local pressure. In sufficiently weak solution its sedative influence tends to allay itching, and the following combination has been found efficient in pruritus: Solution of potassium hydroxide, 4; phenol, 4 to 8; flaxseed oil, 30.

Internal.—Potash is not often used internally, except at times as an antacid for the relief of acid dyspepsia. It has been claimed that it is sometimes successful in reducing obesity, a result attributed to its stimulation of the processes of metabolism, with consequent increased oxidation of proteids and fats; but it seems more probable that in cases of this kind it acts by slowly poisoning the patient, producing disorganization of the blood and interfering with nutrition. It has been used with good results in acne of the face, and is stated to be of service in both promoting and relieving strangury from cantharides. Potash, however, is liable to cause gastric irritation, and hence to obtain the effects of alkalies upon internal organs potassium bicarbonate, citrate and acetate are usually employed in preference to it.

TOXICOLOGY.

See Sodium Hydroxide.

2. **POTASSII CARBONAS.**—Potassium Carbonate. (Salt of Tartar.) **Dose, 1 gm. (15 gr.).**

3. **POTASSII BICARBONAS.**—Potassium Bicarbonate. **Dose, 2 gm. (30 gr.).**

ACTION OF POTASSIUM CARBONATES.

The action of potassium carbonate is essentially the same as that of potassium hydroxide, except that it is much less corrosive. In solution it rarely induces actual lesions of the skin unless after very prolonged application. The hydroxides are much more powerful solvents than the carbonates, and these than the bicarbonates. Hence potassium bicarbonate is but very feebly caustic. Otherwise its pharmacological action is the same as that of the carbonate.

THERAPEUTICS OF POTASSIUM CARBONATES.

In weak solution or as a paste the carbonate is sometimes used externally for the relief of itching in cutaneous diseases. It is also employed in baths, where its irritant action is made use of to soften the epidermis and cause stimulation of extensive areas, as is often desirable in such affections as ichthyosis. For internal use potassium bicarbonate is almost invariably preferred, as carbonates are too irritating to the stomach. Potassium carbonate is used in making Pilulæ Ferri Carbonatis.

Stomach. — While it is always advisable to remove the cause, if possible, the alkalies often serve a very useful purpose in the treatment of dyspepsia. Sodium bicarbonate is much more generally relied upon to give relief, particularly in hyperacidity, than potassium bicarbonate. Where no excessive acidity exists, however, the latter is often preferred, and is commonly efficacious in relieving the distention and discomfort. It should be given in small doses and well diluted, so that it may not irritate the stomach. Alkalies are of great service when there is impaired digestion of fats, not only preventing the formation of butyric acid, but also assisting the emulsification and absorption of the fats. In affections of the liver, and when from any cause the flow of bile into the intestine is interfered with, they are likewise useful in promoting the digestion and absorption of fats. In these conditions potassium bicarbonate is considered preferable to other alkaline remedies. Potash water may be used as a substitute for soda water. It is made by passing carbon dioxide gas, under a pressure of four atmospheres, into an aqueous solution of potassium bicarbonate of the strength of half of one per cent. Potassium bicarbonate should not be employed as an alkali in cases of poisoning by mineral acids, on account of the evolution of carbon dioxide gas which is likely to result.

Blood.—The absorption of both hydroxides and carbonates leads to an increase in the alkalinity of the blood and tissues. Potassium bicarbonate and other alkalies have been used very extensively in the treatment of gout, rheumatism and the so-called uric acid diathesis generally. The explanation offered of their action in these conditions was that the increased oxidation caused by them results in the destruction of a larger amount of the uric acid, while, in addition, the latter, being neutralized in the tissues, is excreted more easily and has less tendency to be deposited. In the light of our present knowledge neither of these theories appears to be tenable. At the same time, there is abundant clinical evidence that the alkalies are of some value in gout and rheumatism, although in the treatment of the latter disease they have to a large extent fallen into disuse since the introduction of the salicylates. It must be confessed, therefore, that their mode of action is not clearly understood, though there is some ground for the belief that these agents may influence the formation, rather than the excretion, of uric acid. In acute rheumatism it has been shown that any influence exerted by the alkaline treatment in cutting short the disease, lowering temperature, and relieving pain, is in no way comparable to that of the salicylates, which, as has been mentioned, have now to a great degree superseded alkalies in the treatment of that affection. The opinion is still held by many experienced observers, however, that alkalies have a decided effect in preventing and relieving cardiac complications, and thus succeed, to some extent, it is claimed, where the salicylates fail. Hence it is the practice of some to associate the latter with alkalies. In acute rheumatism potassium bicarbonate may be given in doses of 1.20 to 2.40 gm. (20 to 40 gr.) every two to four hours, or 15 gm. (½ oz.), or more, may be dissolved in barley water, and administered as a drink during the twenty-four hours. As the remedy is very distasteful to most persons, it may be given in effervescence with lemon-juice, or with citric acid solution. An equal quantity of potassium citrate is sometimes prescribed with the carbonate when given in this way. It has been found that the alkaline treatment, however well adapted it may be to plethoric and muscular individuals, is not usually suited to the delicate and anæmic.

Other Uses.—Potassium bicarbonate is not infrequently used with benefit in jaundice and gall-stone. It probably has no direct effect on the bile, except perhaps in increasing its liquidity, but affords relief principally by lessening duodenal irritation. In bronchitis, added to other expectorants, it serves to increase the secretion and render it less viscid and tenacious.

4. **POTASSII ACETAS.**—Potassium Acetate. **Dose, 2 gm. (30 gr.).**

5. **POTASSII CITRAS.**—Potassium Citrate. **Dose, 1 gm. (15 gr.).**

Preparation.

Liquor Potassii Citratis.—Solution of Potassium Citrate. **Dose, 16 c.c. (4 fl. dr.).**

6. **POTASSII CITRAS EFFERVESCENS.**—Effervescent Potassium Citrate. **Dose, 4 gm. (60 gr.).**

ACTON OF POTASSIUM CITRATE AND ACETATE.

External.—The aqueous solutions of both these salts are alkaline to red litmus paper, but do not affect phenolphthalein test solution. Neither of them has any external action.

Internal.—They are the least irritating to the stomach of all the potassium salts, and, with the exception of the tartrates, the citrate is the least offensive to the palate. They have the advantage of not neutralizing the gastric juice, or in any way affecting the digestion except from their salt-action, which may be minimized by administration in dilute solution. Being decomposed in the body, with the formation of carbonates, they exert an alkaline action after absorption, and this has the effect of increasing the **alkalinity of the blood and of the urine,** and of producing **free diuresis.** On account of its influence on the urinary secretion the acetate was formerly known as *sal diureticus.* The citrate is not so readily absorbed as the acetate, and therefore tends to act on the bowels. It is not cathartic, however, except when given in large quantities. They both have some **diaphoretic** action, which is rather more marked in the case of the citrate. Potassium acetate, like other acetates, is technically a food, as its oxidation supplies energy to the body. Since the acetates, however do not lessen the nitrogenous tissue-change, they are incapable of replacing the fats and carbohydrates, and as they derange the stomach in the same way as common salt, and also alter the character and amount of the urine, they are found to be practically useless as foods.

Therapeutics of Potassium Citrate and Acetate.

Blood.—Both these salts are largely employed in gouty conditions, and were formerly much used also in the alkaline treatment of acute rheumatism. The citrate dissolved in an excess of lemon juice affords the most agreeable method of securing the influence of an alkaline potassium salt upon the system. They have some **antiscorbutic** effect, but are not so efficient in the prevention and treatment of scurvy as lemon-juice, lime-juice, and fresh vegetables.

Kidneys.—They are constantly used for their diuretic effect in feverishness, scarlatinal dropsy, chronic renal disease, general dropsy from valvular disease of the heart, and other conditions. Alkaline diuretics are of very little value, however, in dropsical accumulations in the various cavities. The best effects are usually obtained from a combination of diuretic remedies, and the following mixture will be found serviceable: Potassium acetate, 1.20 gm. (20 gr.); tincture of squill, .60 c.c. (10 ♏); spirit of nitrous ether, 2.00 c.c. (30 ♏); juice of broom, 4.00 c.c. (1 fl. dr.); water, to 30.00 c.c. (1 fl. oz.). Juice of broom is obtained by bruising fresh broom tops, expressing the juice, adding one-third part of alcohol, and filtering after seven days. In irritation of the urinary organs resulting from an excess of acid and in inflammatory conditions of the passages, in which the acid urine acts as an irritant, they are of great service by rendering the urine alkaline, and they possess the advantage over other potassium salts of not affecting the stomach or interfering with digestion. In such conditions the Liquor Potassii Citratis is highly esteemed. It was long the opinion, and is still held by many, that the continued use of these salts will effect the solution of renal calculi, which are usually composed principally of uric acid. It has been shown, however, that the alkaline treatment is incapable of removing calculus either in the bladder or kidney. While outside the body free alkalies and their carbonates dissolve uric acid quite readily, it is found that the solution of the alkalies formed in the urine is extremely dilute, the reaction, except under large doses, being in fact not even constantly neutral. On the other hand, it is pointed out, even the alkaline urates are by no means very soluble bodies, and are formed only with difficulty except in strong alkaline solutions. Some authorities contend that the alkalies, not being excreted as such, nor as carbonates, cannot convert free uric acid into soluble alkaline urates, but at most into acid urates, which are almost as insoluble as uric acid itself. Hence, it would be absolutely impossible to effect in this way the solution of even very small calculi. The fact that in certain instances alkaline treatment has been observed to cause the breaking up of large stones into small fragments is explained on the hypothesis that the calculi were composed originally of small fragments glued together by mucus, and that the alkali caused the solution of the latter. Furthermore, it is claimed that the alkalies are to some extent objectionable in vesical calculus, inasmuch as alkaline urine is liable to deposit phosphates in the bladder, and thus rather to increase the size of the stone than to diminish it. Still, there can be no question that in any of the forms of irritation of the urinary passages (from gravel, stone, cystitis, stricture, enlarged prostate, etc.), such agents as potassium citrate and acetate afford great relief whenever the urine is acid in reaction. There is also high authority for the opinion that they are of utility in the prevention of uric acid gravel, it being held that the most potent factor in determining the precipitation of free crystalline uric acid in the urinary passages is a high degree of acidity in the urine; so that if the latter be rendered alkaline, or only faintly acid, no such precipitation can occur. In the daytime the alkaline tide following the ingestion of meals will usually keep the urine from attaining an acidity sufficient for the precipitation to occur, but during the fasting hours of the night the opportunity for this is afforded. Hence, it is advised that a moderately large dose of an alkali, such as 2.50 to 4.00 gm. (40 to 60 gr.) of potassium citrate should be taken at bedtime. In case this is not sufficient to prevent the hyperacidity during all the hours of sleep, a second dose should be taken in the course of the night, while in exceptional instances the tendency to uric acid precipitation may be so great as to require the use of the remedy in the daytime also. This preventive treatment, it can readily be seen, may be materially aided by a judicious arrangement of the meals, so as to avoid unnecessarily prolonged periods of fasting.

Skin.—In feverish conditions, such as frequently result from an ordinary cold, they are of service on account of their diaphoretic as well as their diuretic action.

Respiratory Passages.—Like potassium bicarbonate, they are of considerable utility in bronchitis, assisting the action of other expectorants by increasing the secretion and by rendering it more fluid and more easily expectorated.

7. **POTASSII SULPHAS.**—Potassium Sulphate. **Dose, 2 gm. (30 gr.).**

8. **POTASSII BITARTRAS.**—Potassium Bitartrate. (Acid Potassium Tartrate. Cream of Tartar.) **Dose** (diuretic), **2 gm. (30 gr.).**

ACTION OF POTASSIUM BITARTRATE AND SULPHATE.

External.—The aqueous solution of potassium bitartrate has an acid reaction on litmus paper, but it is only slightly acid, while the sulphate is neutral. Neither has any external action.

Internal. *Intestines.*—They are **hydragogue saline cathartics,**

drawing fluid from the blood and tissues into the intestine, and consequently rendering the blood more concentrated than usual. This leads to a sensation of thirst and to a lessened excretion of fluid by the kidneys and other glands. They produce rather profuse watery stools, with practically no irritation or griping. To the sulphate, however, the last statement applies only when it is given in comparatively small doses (.60 to 2.40 gm.; 10 to 40 gr.) and freely diluted. In large doses and when insufficiently diluted it is a **powerful irritant**, and from 45 to 60 gm. (1½ to 2 oz.) has been known to cause fatal gastro-enteritis, while 15 gm. (4 dr.), if not properly diluted, may give rise to grave symptoms. In France it is stated to be used as a popular abortifacient; the ecbolic effect being secondary to the inflammation produced in the alimentary canal.

Liver.—Potassium sulphate has been supposed to have some action in increasing the biliary secretion, but, as in the case of other saline purgatives regarded as cholagogues, this has now been shown to be incorrect.

Kidneys.—The bitartrate, which is but slowly absorbed, is to a large extent excreted unchanged in the urine and fæces. That portion which is absorbed is converted into carbonate, which has a decided **diuretic** effect and also tends to render the **urine alkaline**. All the sulphate is believed to be excreted unchanged; consequently, it has no remote effects.

THERAPEUTICS OF POTASSIUM SULPHATE AND BITARTRATE.

Gastro-Intestinal Tract.—Potassium sulphate, while used to some extent in Europe, is rarely ever prescribed in this country; magnesium and sodium sulphates being much preferred to it. The bitartrate is frequently employed as a cooling aperient, and for this purpose a dose of it (2 to 8 gm.; ½ to 2 dr.) may be dissolved in a glass of hot water, and sipped during dressing in the morning. Its use should not be continued regularly too long, however, as it is liable to impair nutrition. In doses of 15 to 30 gm. (½ to 1 oz.) it is a valuable hydragogue cathartic, particularly in dropsy and uræmia. It is often combined with senna, magnesia or sulphur, or with jalap, as in compound jalap powder. With sulphur or with confection of senna it constitutes a convenient laxative when hæmorrhoids are present. With magnesia it is sometimes prescribed in habitual vomiting arising from gastric acidity and also in the vomiting of pregnancy.

Kidneys.—The bitartrate is highly esteemed as a diuretic, and 30 gm. (1 oz.) in 500 c.c. (1 pint) of infusion of juniper-berries, taken in divided doses during the twenty-four hours, is often very serviceable in dropsy. This is too irritating to the kidneys, however, to be used in acute desquamative nephritis. Cream of tartar whey is made by dissolving about 8 gm. (2 dr.) of the bitartrate in 500 c.c. (1 pint) of milk. The beverage known as "imperial" (potus imperialis) may be used with advantage in some febrile affections. It consists of potassium bitartrate, 4 gm. (1 dr.); saccharin, .06 gm. (1 gr.); oil of lemon, .20 c.c. (3 ♏); to 500 c.c. (1 pint) boiling water. The bitartrate is also conveniently given in ordinary lemonade, the salt being dissolved in hot water and the solution allowed to cool before the lemons are added to it. Compound jalap powder is rendered more efficient, both as a diuretic and a purgative by the addition of .60 gm. (10 gr.) of potassium bitartrate to each dose.

Liver.—In hepatic cirrhosis, whether due to alcoholism or other causes, as well as in chronic peritonitis, good results are said to be sometimes obtained from potassium bitartrate. Both the bitartrate and the sulphate have been used in gall-stone disease.

9. POTASSII NITRAS.—Potassium Nitrate. (Nitre. Saltpetre.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ACTION OF POTASSIUM NITRATE.

External.—It has no action on the unabraded skin, but is irritant to mucous membranes and raw surfaces.

Internal.—*Gastro-Intestinal Tract.*—In small doses it is unirritating. In large quantities it is a decided **gastro-intestinal irritant,** producing nausea, vomiting, intense burning pain in the stomach, and sometimes purging. In some instances blood is present in the matters vomited and in the stools. After death there is found congestion of the stomach and intestines, and there may be extravasations of blood. Even ulceration and corrosion of the mucous membrane have been observed. When it is very freely diluted, however, the local irritant action of the drug is in great measure prevented, and very considerable quantities may be taken without serious results.

Blood.—External to the body, nitrates have the effect of preventing the coagulation of the blood and of dissolving clots already formed. In the body they are said to have some influence on the red blood-corpuscles, which become crenated; but it is thought that this is probably merely the salt-action, and not any specific nitrate effect. By reason of its high diffusion power potassium nitrate rapidly passes into the blood unchanged.

Heart.—It is so violently irritant that the local symptoms produced by toxic quantities are apt to overshadow the effects on the system of its potassium ion. The latter, however, is **depressant** to the heart, weakening its movements and finally arresting them.

Nervous System and Muscles.—Sometimes the nervous symptoms predominate, and the collapse caused by the drug may be accompanied with paralysis of the lower extremities. It tends to exert a paralyzing influence upon the spinal cord, and produces great muscular weakness and reduction of reflex sensibility. It also tends to paralyze unstriped muscular fibre.

Respiration.—Large doses retard the respiration.

Skin.—It has a slight **diaphoretic** effect.

Kidneys.—In moderate amounts it has considerable **diuretic** influence, which is believed to be due in part to the salt-action and partly to a true stimulation of the kidney, such as is exerted by many other intestinal irritants. Large quantities tend to produce renal inflammation and hæmaturia, and in some cases of poisoning the kidney is recorded to have presented the lesions of acute nephritis, and also hæmorrhages.

Elimination.—Some of the nitrate given by the mouth is usually found unchanged in the urine, but the greater portion disappears in the tissues. Its fate in the body is not certainly known, but it is supposed that it is reduced first to the nitrite, and then to ammonia, or that it is eventually excreted by the lungs as free nitrogen. Some of the nitrate is apparently excreted in the saliva and perspiration; it may be unchanged, although it is said to be rapidly reduced to nitrite in these secretions, and may in fact be changed to this form in the secretory cells.

THERAPEUTICS OF POTASSIUM NITRATE.

It was formerly used to a large extent in febrile diseases, and especially acute rheumatism. At the present time, however, its internal administration for any purpose has been in great measure abandoned. It is stated, however, to be sometimes of value in the treatment of hæmorrhage, more particularly hæmoptysis accompanied with febrile movement, and to have been given with advantage in purpura simplex (in 60 gm.; 10 gr. doses) and purpura hæmorrhagica (in doses of from .60 to 4 gm.; 10 to 60 gr.). As a diuretic it has been almost entirely superseded by the citrate and acetate, but is still used by some as an ingredient of diuretic mixtures, with digitalis and other drugs. When given internally it is recommended that it should be carbonated in order that its absorption may be accelerated and the gastric irritation proportionately lessened. A small amount (.12 gm.; 2 gr.) in a glass of sweetened water will, it is said, relieve the hoarseness to which speakers and singers are liable. By reason of its influence on the respiration and on unstriped muscular fibre, potassium nitrate acts as an antispasmodic, and the one great purpose for which it is now employed is the relief of the symptom asthma. For the treatment of this, linen or blotting paper, dipped in a saturated solution of nitre and then dried, is burned, and the patient inhales the fumes. It is advised by some that the paper should be also dipped in a solution of potassium chlorate. The fumes may be diffused generally in the room, or if a more concentrated effect is desired the paper may be burned under a funnel, from the mouth of which the patient inspires. The nitrate is a common ingredient of so-called asthma powders, and is also sometimes used in the form of cigarettes. Powdered nitre, moistened with water and applied to the face night and morning, is useful for removing freckles.

10. POTASSII CHLORAS.—Potassium Chlorate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Trochisci Potassii Chloratis.—Troches of Potassium Chlorate.

ACTION OF POTASSIUM CHLORATE.

External.—Locally it is disinfectant and stimulant to mucous membranes. It is easily decomposed by septic tissues, and the nascent oxygen given off acts as a stimulant and antiseptic to them.

Internal. *Stomach and Intestines.*—Small doses have no effect. Sometimes the only effect in the alimentary canal of large doses is to cause some nausea and vomiting. In other instances the **irritation** caused by it is sufficient to excite gastroenteritis. The first symptom is often prolonged and violent vomiting. There is severe gastric pain, and this may be followed by profuse diarrhœa. In subacute poisoning vomiting and diarrhœa are also observed, and the matter vomited usually contains bile, and sometimes blood. The nausea and vomiting are believed to be principally due to the local salt-action of the drug, but that this is not their only cause seems to be shown by the fact that vomiting has been observed in animals in which the chlorate was injected subcutaneously. After death swelling and ecchymosis of the mucous membrane of the stomach and intestines have been found.

Blood.—When added to blood, either outside or in the body, it causes the formation of **methæmoglobin** from the conversion of hæmoglobin; so that its administration in toxic quantity may produce an actual **asphyxia.** It also has the effect of subsequently causing the **destruction of the red blood-cells,** with resulting liberation of proteids. In the most acute form of intoxication death is due chiefly to asphyxia caused by the reduction of a large amount of hæmoglobin, but if the quantity of methæmoglobin thus formed is smaller, it is found that the latter gradually disappears. Hence, in the subacute form of poisoning sufficient hæmoglobin remains untransformed to continue the respiration of the tissues. When cases of this kind terminate fatally some of the red corpuscles are found altered in shape, others are colorless, and in some the pigment, instead of being generally diffused, is aggregated in masses. No methæmoglobin may be discovered, but the débris of the corpuscles can be found in the liver, spleen, bone-marrow and renal tubules. In acute poisoning the color of the blood is very dark and the methæmoglobin absorption band is found present in the spectrum.

Heart and other Organs.—Toxic doses are likely to cause great failure of the heart's action, excessive dyspnœa, and marked cyanosis of the surface. Increase in the amount of bile pigment results from the excessive destruction of red blood-corpuscles, and the absorption of the pigment from the bile capillaries may cause jaundice. After death both the liver and spleen have been found enlarged, from the deposition of the débris in them.

Nervous System.—Among the nervous symptoms noted are headache, delirium, tonic and clonic spasms, coma, and a peculiar stiffness of the extremities. These are believed to be due, not to any specific effect upon the central nervous system, apart from the salt-action of the chlorates, but to the blood changes caused by the drug and to the **uræmia** resulting from its effects in the kidneys. The course of the poisoning may be very rapid, death having been known to be caused in two and a half hours; but usually it does not occur for several days. The fatal result may be due either to asphyxia, to collapse from cardiac weakness, or to uræmia. Death from uræmic symptoms may follow as late as a week after the appearance of the first signs of poisoning, while in several instances complete recovery has occurred where the most severe effects had been caused. A rare effect of potassium chlorate is the production on the skin of an erythematous, vesicular or papular eruption.

Kidneys.—The effects of potassium chlorate in the kidneys are of great interest. In the subacute form of poisoning the products of the destruction of the red blood-corpuscles are excreted in the urine, and in consequence the renal tubules become stopped up with brown granular masses. These are found to be in part forced downwards and to appear in the urine as casts, but may produce an almost complete suppression of urine and the consequent symptoms of uræmia. Probably as the result of the plugging of the tubules, the epithelial cells may perhaps become inflamed, but often, it is stated, no actual nephritis is present. The opinion formerly held that the chlorate becomes reduced and yields its oxygen in the system has been shown to be entirely incorrect. It passes unchanged through the body, being principally excreted in the urine, from which 90 to 96 per cent. of the amount given by the mouth has been recovered. It is also excreted in small quantities in the perspiration, saliva, tears, and probably all the other secretions, and is stated to pass from the mother to the fœtus in utero. While the secondary effect of potassium chlorate may tend to produce suppression of the urine, through the results in the kidneys of its destructive influence on the red blood-cells, the absorption of concentrated solutions is often shortly followed by considerable **diuresis**, from an action upon the kidney similar to the local salt-action in the stomach which induces nausea and vomiting.

THERAPEUTICS OF POTASSIUM CHLORATE.

In the case of no drug has a greater change of opinion taken place than as regards potassium chlorate. Under the supposition that it yielded its oxygen to the blood it was for many years extensively used in adynamic fevers and in diphtheria and other diseases attributed to blood-poisoning. Its internal use, however, is now regarded as of little value, and may cause toxic symptoms; but locally it has distinctly curative effects upon mucous membrane in such conditions as catarrhal inflammation of the mouth and fauces, aphthous, ulcerative and mercurial stomatitis, and thrush, or nursing sore-mouth, as well as in acute tonsilitis. Its local action is not clearly understood. It has been suggested that it is an oxidizing disinfectant, but there appears to be no ground for supposing that it is changed here any more than in the tissues in general. It may be applied in the form of a wash or gargle, and is sometimes associated with other agents. In young children solutions of it are used with glycerin, honey or syrup to wash out the mouth. Of course, it is essential to the success of the treatment that the general condition of the patient should also be carefully looked after. It is sometimes given internally in solution, or in the form of lozenges, with the idea of obtaining its local effect while being swallowed and a subsequent similar effect from its excretion in the saliva. If it has no beneficial systemic action it would seem preferable to depend entirely on its local application, which can be repeated as often as the circumstances require, and thus avoid the possibility of poisoning the patient. On account of this danger the use of potassium chlorate lozenges is condemned by some authorities. If the salt is employed internally it should always be administered with great caution, and pains should be taken to avoid giving it on an empty stomach. In diphtheria it has been thought especially effective in combination with tincture of ferric chloride and hydrochloric acid, in which, in addition to the local influence of the chlorate and the tonic effect of the iron, the action of free chlorine, generated in the mixture, is obtained. It should not be exhibited in full doses, however, on account of the depressing effects upon the heart, as well as the danger of renal trouble. A teaspoonful of the following may be given undiluted every two hours: To 4 gm. (1 dr.) of powdered potassium chlorate, mixed with 6 c.c. (1½ fl. dr.) of hydrochloric acid, are added 8 c.c. (2 fl. dr.) of tincture of ferric chloride and enough water to make 120 c.c. (4 fl. oz.). In order to render it less disagreeable to the taste a considerable proportion of the water may be substituted by glycerin or a syrup such as that of blood orange. Diluted, this mixture makes an excellent gargle. A solution of potassium chlorate in glycerin (one part to ten) has been highly commended as a dressing for ill-conditioned wounds and ulcers.

TOXICOLOGY.

As potassium chlorate is very largely used as a domestic remedy and is not regarded by the laity as a toxic agent, accidental poisoning from it is not unlikely to occur. The injurious effects of the drug have already been sufficiently described. In the treatment the stomach should be promptly evacuated if there is reason to suppose that any of the salt still remains in it. Demulcents such as white of egg, milk, flaxseed tea, or mucilage of acacia may be used, and ice given to control the vomiting. Each case should be treated according to the special symptoms met with. Cardiac stimulants or stimulants to the central nervous system may be called for. As the destructive action of the chlorate upon the blood is believed to be less liable to occur when the latter is more alkaline than usual, the alkaline carbonates should generally be given in the hope of preventing or checking these effects. After the acute symptoms have passed off the administration of diuretics and large quantities of fluid is recommended for the purpose of washing out the kidneys and preventing the accumulation of detritus in the tubules.

SODIUM.

1. **SODII HYDROXIDUM.**—Sodium Hydroxide. (Caustic Soda. Sodium Hydrate.)

Preparation.

Liquor Sodii Hydroxidi.—Solution of Sodium Hydroxide. (Solution of Soda.) **Dose, 1 c.c. (15 ♏).**

ACTION OF SODIUM HYDROXIDE.

Its action is practically the same as that of potash. The principal difference between the effects of the sodium and potassium salts, when given in large amount, is the more depressant influence of the latter upon the cardiac, muscular and nervous systems. It must be borne in mind, however, that sodium hydroxide and carbonates, like the potassium hydroxide and carbonates, depend chiefly for their activity on their alkalinity, and not on their metallic constituent. It is their hydroxyl ion which induces the alkaline reaction of the solutions and determines their physiological effects.

THERAPEUTICS OF SODIUM HYDROXIDE.

It is very little used. Potash is almost always preferred.

TOXICOLOGY.

Poisoning by caustic alkalies is not very commonly met with. In addition to potash and soda, it may be caused by the impure potassium carbonate (pearlash) or sodium carbonate (soap lees), which contain these alkalies. The carbonates, however, are much less corrosive than the hydroxides.

Symptoms.—The symptoms are those of a violent corrosive poison: burning heat in the throat and stomach, intense thirst, salivation, vomiting of blood-stained matter, agonizing abdominal pain accompanied with diarrhœa, feeble pulse, cold, clammy skin, and general collapse. The lips, mouth, tongue and throat become swollen and assume a bright red color. The larynx is apt to be involved in the corrosive action, and œdema of the larynx may cause death in a very brief time. If the patient should survive the immediate effects of the poison he is very likely to suffer from more or less extensive ulceration or cicatrization of the mucous membrane of the throat, œsophagus or stomach, which may subsequently prove fatal. In very exceptional instances the local action may be comparatively slight, and the principal effect of the poison expend itself upon the nervous system, with the result of producing muscular weakness, paralysis of the lower extremities, weak cardiac action, and coma; and, as has been stated, very large doses cause death suddenly, through paralysis of the heart, before the local inflammation has had time to develop.

Post-mortem Appearances.—The mucous membrane, wherever the caustic has come in contact with it, is dark-colored, inflamed and covered with a grayish membrane. The sloughs may be very extensive and deep, and there may even be complete destruction of a portion of the stomach wall. In the event of the patient's having survived long enough for such sequel to occur, there will naturally be found evidences of peritonitis resulting from this lesion. In the œsophagus the points especially affected will generally be found at its two ends and at the place where it crosses the left bronchus, and in the stomach, at the pylorus.

Treatment.—The stomach should be evacuated as promptly as possible, but it is not safe to use the stomach-pump for this purpose, as the tube is liable to perforate the corroded wall of the œsophagus or stomach. Any one of the following emetics may be resorted to: Apomorphine hydrochloride, .006 gm. ($\frac{1}{10}$ gr.), by subcutaneous injection; zinc sulphate, 1.20 gm. (20 gr.), or copper sulphate, .30 gm. (5 gr.), in 250 c.c. (½ pint) of tepid water; powdered ipecacuanha, 2.00 gm. (30 gr.) or wine or syrup of ipecacuanha, 30 c.c. (1 fl. oz.). The preparations of ipecacuanha should not be employed if other emetics are available, as this drug, which produces vomiting chiefly by its influence on the medulla oblongata, is not sufficiently prompt in its action. If none of these agents is quickly attainable, domestic remedies such as mustard, 16 gm. (1 tablespoonful) or common salt, 30 gm. (2 tablespoonfuls), may be administered in 250 c.c. (½ pint) of tepid water. At all events, plenty of lukewarm water should be given, and vomiting promoted by tickling the fauces. As soon as the stomach has been emptied some form of dilute acid should be employed. The organic acids—acetic, citric or tartaric—are the best, and vinegar is almost always within easy reach. In place of it, lemon juice, acetic acid, or solution of citric acid (all of which should be well diluted with water) may be used. Demulcents such as white of egg, olive oil, or flaxseed tea are of service, and measures to counteract shock, heart-failure, and collapse, such as the application of warmth, the exhibition of stimulants, etc., are also generally called for.

2. **SODII CARBONAS MONOHYDRAS.**—Monohydrated Sodium Carbonate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Unofficial Preparation.

Sodii Carbonas Exsiccatus.—Dried Sodium Carbonate. **Dose, .30 to 1.00 gm.; 5 to 15 gr.**

ACTION OF SODIUM CARBONATE AND THE DRIED CARBONATE.

As in the case of potassium, the carbonate is much less corrosive than the hydroxide. With this exception, the action is the same as that of caustic soda. Sodium carbonate is, however, decidedly more irritating than the bicarbonate.

THERAPEUTICS OF SODIUM CARBONATE AND THE DRIED CARBONATE.

A one per cent. solution of dried sodium carbonate is used for boiling surgical instruments in the process of sterilization, in order to prevent their rusting. The carbonate is also employed externally to some extent in the treatment of skin diseases in which the eruption is of a dry character, as lichen, prurigo, ichthyosis, psoriasis and pityriasis, and especially in the form of baths. From 125 to 450 gm. (4 to 16 oz.) is dissolved in a sufficient quantity of tepid water, and it is advised that each bath should be at least an hour in duration. It has the effect of stimulating the affected portions of the skin, and at the same time of removing sebaceous and acid secretions. If, however, there is already an irritable condition present, but a small quantity of the alkali should be used, and mucilage or bran may be added to the water to render the bath more bland. This treatment is generally unsuitable for vesicular and pustular eruptions, but may occasionally prove of service in them if the solution is made very weak. Lotions containing sodium carbonate have been used in certain local eruptions, especially those of the scalp, and also in pruritus vulvæ. The salt is rarely employed internally except as it occurs in alkaline mineral waters. As an antidote to acids in corrosive poisoning, however, it is regarded as preferable to the bicarbonate, for the reason that less carbon dioxide is formed.

3. **SODII BICARBONAS.**—Sodium Bicarbonate. (Baking Soda. Soda.) **Dose, 1 gm. (15 gr.).**

Preparation.

Trochisci Sodii Bicarbonatis.—Troches of Sodium Bicarbonate.

ACTION OF SODIUM BICARBONATE.

As regards general alkaline properties the action of sodium bicarbonate is the same as that of potassium bicarbonate, but it differs from it in being less rapidly absorbed from the alimentary canal. It is much more grateful to the stomach than either sodium or potassium carbonate.

THERAPEUTICS OF SODIUM BICARBONATE.

External.—Either in saturated solution or as a fine powder sodium bicarbonate, locally applied, is the best remedy to relieve the pain from burns. Of late it has been strongly recommended to be used for packing to prevent pain after operations upon the vagina. To relieve itching a lotion of .50 gm. (7 gr.) to 30 c.c. (1 fl. oz.) may be employed, and a saturated solution has been found an efficient cure in poisoning by rhus toxicodendron. Applied in powder to the tonsils in the initial stage of acute tonsilitis, it is claimed that it will often prevent the further development of the disease.

Internal.—In dyspeptic conditions, and especially hyperacidity of the stomach, it is much more commonly used than any other alkali. Among the symptoms for the relief of which it may be employed are heartburn, sour eructations, œsophageal spasm, cramp in the stomach, colic, and irregular diarrhœa. In cases of hyperacidity it is commonly given after meals, often affording immediate relief, and, like other alkaline preparations, it should be always well diluted in order to avoid undue irritation. When the secretion does not seem to contain an excessive amount of acid it is sometimes prescribed before meals, and it may then be combined with other stomachics, such as bitters or volatile oils. Dilute solutions of the alkalies act as mild irritants to the stomach wall, and thus, it is thought, improve its circulation, and lessen pain, eructation and distention in the same way as other slight gastric irritants, such as the volatile oils, while in the case of the carbonates and bicarbonates this carminative action is strengthened by the carbon dioxide liberated by the hydrochloric acid. Furthermore, by their mild irritant action they increase mucus-secretion, and as they also have the effect of liquefying tenacious mucus, they serve to improve the condition of the stomach. If there is hyperacidity in the intestine, rather than the stomach, sodium bicarbonate is not suitable, because it is likely to be neutralized or absorbed before reaching the seat of trouble. In this case the insoluble alkaline earths or their carbonates should be advised. While the immediate result of potassium bicarbonate in hyperacidity of the stomach is highly beneficial, the after-effect is to increase the production of acid; so that those who habitually use the remedy for acid indigestion are extremely apt to suffer severely from acidity. It is very serviceable in the acid diarrhœa of infants and young children, where it is often given combined with demulcents or with the aromatic syrup of rhubarb. An important application of the salt is as an emetic in narcotic stupor when other emetics fail to act. From 2 to 4 gm. (30 to 60 gr.) in solution in water is given to the patient (by means of the stomach tube if necessary), and this is followed by a similar quantity of tartaric acid. Brisk effervescence results, and the contents of the stomach are evacuated. The same expedient has been successfully tried in intussusception, in this case the two drugs being successively injected into the rectum. Strong pressure being made on the anus to prevent its escape, the gas generated urges its way upward and forces the invaginated gut back to its normal position. A stomach or bowel much softened by inflammation or weakened by ulceration would constitute a contra-indication to this practice. Brilliant results have been reported from the use of sodium bicarbonate and carbonate in the treatment of diabetic coma, when given early enough and in sufficient amount. If the alkali is used in the early stages before coma sets in, it is advised that it should be given in quantities of about 40 gm. (10 dr.) a day, while if coma has already supervened the amount should be 100 or 200 gm. (25 or 50 dr.). If catharsis occurs after these large doses, so much of the alkali may escape by the bowels that it may be impossible to secure the absorption of a sufficient quantity. In this event it should be given by intravenous injection of a 0.3 per cent. solution of the crystallized salt, as hypodermatic injection is apt to cause sloughing. It is insisted on that the administration of the remedy should not be left until coma actually occurs, as it may then be too late, and it is recommended that the treatment should be instituted as soon as the urine gives the characteristic reaction of acetone with ferric chloride. In digestive troubles sodium bicarbonate is often combined with gentian, and a common gastric sedative mixture consists of .60 gm. (10 gr.) each of sodium bicarbonate and bismuth subcarbonate, suspended in mucilage. A useful stomach powder for children is composed of .06 or .12 gm. (1 or 2 gr.) of the bicarbonate and .06 gm. (1 gr.) of pulverized rhubarb, with a little sugar. Effervescing soda water may be made from sodium bicarbonate in the same way as potash water from potassium carbonate (*see* p. 145).

4. SODII SULPHAS.—Sodium Sulphate. (Glauber's Salt.) **Dose, 16 gm. (240 gr.).**

5. SODII PHOSPHAS.—Sodium Phosphate. **Dose, 2 gm. (30 gr.).**

Preparations.

1. Sodii Phosphas Effervescens.—Effervescent Sodium Phosphate. **Dose, 8 gm. (120 gr.).**

2. Sodii Phosphas Exsiccatus.—Exsiccated Sodium Phosphate. **Dose, 1 gm. (15 gr.).**

3. Liquor Sodii Phosphatis Compositus.—Compound Solution of Sodium Phosphate. **Dose, 8 c.c. (2 fl. dr.).**

6. POTASSII ET SODII TARTRAS.—Potassium and Sodium Tartrate. (Rochelle Salt.) **Dose, 8 gm. (120 gr.).**

Preparation.

Pulvis Effervescens Compositus.—Compound Effervescing Powder. (Seidlitz Powder.) **Dose, one set of two powders.**

Action of Sodium Sulphate and Phosphate, and of Potassium and Sodium Tartrate.

Internal. *Intestines.*—These are typical **saline cathartics**, differing from vegetable cathartics in not causing irritation of the intestine, except when given in very large quantities. They owe their action, not to irritation, but to retarded absorption, and their characteristic effect is due to their acid constituent. Saline cathartics cause the abstraction of fluid from the blood and its accumulation in the intestine. The quantity of liquid accumulated depends upon the nature and amount of the salt and the strength of the solution employed, and it has been found that the maximum amount corresponds closely to the quantity required to form a 5 or 6 per cent. solution of the salt employed. The liquid withdrawn from the blood is quickly replaced by liquid abstracted from the tissues, but there is a secondary concentration of the blood later, resulting from the subsequent diuresis occasioned by the portion of the salt absorbed. After the maximum of accumulation in the intestine is reached, the fluid is gradually absorbed, and a soft painless motion generally occurs within two or three hours after the administration of the drug. The sulphate is the most active of these sodium salt cathartics, and it forms an important constituent of many well-known mineral waters. It is the chief ingredient of Carlsbad, Marienbad, Franzensbad, Tarasp, Villacabras and Rubinat Condal waters, and occurs in association with magnesium sulphate in Friedrichshall, Hunyadi Janos, Apenta, Seidlitz, Kissingen, Pullna, Æsculap and Franz Joseph waters. Both the sulphate and phosphate are mild cholagogues, and Carlsbad waters have been shown to increase the amount, as well as the solid constituents, of bile.

Blood and Kidneys.—On account of the slowness of their absorption they have less influence than the corresponding salts of potassium in rendering the blood and urine alkaline and in causing diuresis. It is said, however, that the basic portion of sodium sulphate is excreted much more quickly than the acid, so that the urine may be rendered alkaline temporarily. It is also stated that the intravenous injection of this salt produces a copious diuresis.

Therapeutics of Sodium Sulphate and Phosphate, and of Potassium and Sodium Tartrate.

On account of its extremely nauseous taste, the sulphate is rarely used in this country, except as it occurs in the various aperient mineral waters. The taste may be in some degree disguised by the addition of a few drops of aromatic sulphuric acid, or by giving it in lemonade. In dysentery good results have been obtained from it in daily quantities of 10 gm. (2½ dr.). Its use as an antidote in phenol poisoning, which was at one time recommended, on the supposition that it forms phenolsulphonates, which are not so poisonous, has been shown to be quite without effect on the progress of the intoxication. This, it is believed, is due to the fact that phenol does not combine with sulphates, as such, in the body, but with organic sulphur compounds which are only in process of being oxidized to sulphuric acid. Rochelle salt is employed to a very considerable extent as a mild saline purgative. Although much less efficient, it is far less disagreeable to take than either magnesium or sodium sulphate, and is especially acceptable in Seidlitz powders (Pulvis Effervescens Compositus), which form an effervescing draught. In small repeated doses it does not purge, and serves to render the urine alkaline. The phosphate is not so powerful a cathartic as the sulphate, but is also less offensive to the palate, and is used more or less in the case of children. Both these salts are often of service in gall-stones, probably chiefly by improving the condition of the mucous membrane of the intestine. The phosphate is useful in various affections of the liver, and is thought of especial value in cirrhosis, if commenced early and persistently administered. The belief has been expressed that it has the power to retard the development of the changes taking place in this disease, and, possibly, under favorable circumstances, to arrest them and to restore a comparatively normal functional state. By correcting a catarrhal condition of the duodenum its persevering employment is often efficacious in the prevention of biliary calculus. This salt is also useful in catarrhal jaundice. It is stated to have seemed very beneficial in the hepatic form of diabetes, and that it is of great service, especially when combined with sodium arsenate, in obese subjects when a succession of boils portends the development of diabetes. When dissolved in a proper amount of water the following powder constitutes a good imitation of Hunyadi Janos, Æsculap, Franz Joseph and other natural waters: 2 gm. (30 gr.) each of sodium sulphate and magnesium sulphate, and .06 gm. (1 gr.) each of sodium chloride and sodium bicarbonate; dose, 4 to 15 gm. (1 to 4 dr.). The combination of 60 gm. (2 oz.) of sodium phosphate, 15 gm. (4 dr.) of sodium sulphate, and 2 gm. (30 gr.) of potassium iodide, taken upon rising in sufficient laxative doses and well diluted, is said to be very efficient in such cases as are benefited by Carlsbad waters. All such remedies are more active when used hot. There can be no question of the value of the Carlsbad treatment in many cases of cholelithiasis, gouty dyspepsia, catarrh of the stomach and intestines, obesity, and other conditions, but it is highly probable that the benefit derived from it is largely due to the change in habits and the restricted diet prescribed, as well as to the medicinal virtue of the waters. In administering all saline cathartics it should be borne in mind that they produce their proper effect only when given in solutions of a certain degree of dilution. Often it appears that just in proportion to the dilution of such a salt is its relative efficiency as a purgative, and this is well illustrated in the case of the natural mineral waters that have been referred to, which are purgative in quantities which contain only an inconsiderable proportion of the neutral salts. The phosphates have been supposed to be of benefit in nervous diseases, on the theory that these were due to the insufficiency of phosphorus in the brain, but there is high authority for the statement that the animal organism is unable to form combinations between phosphates and proteids. At the same time some neurologists claim to have obtained good results from the use of sodium phosphate in a number of these affections. In facial neuralgia, neurasthenia and hysteria it is stated that the results are often very satisfactory. Subcutaneous injections were employed of a mixture consisting of sodium phosphate, 1, rectified spirit, 2, and distilled water, 60. Of this 1 c.c. (15 ♏) were injected daily, and the amount gradually increased to 3 c.c. (45 ♏). While believed to have only a pallative effect in organic disorders of nerve centers, this method is reported to have been attended with marked improvement in certain cases of locomotor ataxia.

7. SODII CHLORIDUM. — Sodium Chloride. (Common Salt.) **Dose** (emetic), **16 gm. (240 gr.).**

ACTION OF SODIUM CHLORIDE.

Sodium chloride, which is an important constituent of the animal economy, has practically no specific action. Its effects are limited to the alteration in the fluids produced by its excess or deficiency, and they present a typical example of what is known as **salt action.** As its molecular weight is small and as it dissociates readily into its two ions, it possesses great osmotic power. This is made use of in the preservation of meats, which it effects by causing the withdrawal of their fluids and in this way rendering them hard and unfavorable for the development of microbes. Strong salt solutions, placed in contact with skin or mucous membrane, withdraw fluid from the surface cells, and this, together with the passage of salt into them, causes some irritation. They also withdraw fluid from the red blood-corpuscles, which shrink in size, and from muscle, the vitality of which is impaired. On the other hand, with very dilute solutions these all become swollen and softened from the absorption of fluid. Salt solutions which are more concentrated than the blood-plasma are called *hypertonic,* those which are weaker than it, *hypotonic,* and those which are of the same osmotic pressure as the plasma, *isotonic.* When two solutions are separated by a semi-permeable membrane, neither of the salts in solution being able to penetrate the membrane, water accumulates on the side of the solution having the highest osmotic pressure. The osmotic pressure of a given substance is proportional to the number of molecules per volume of solution. A 0.7 per cent. solution of sodium chloride is called the **normal** or **physiological saline solution** because it is supposed to be isotonic or indifferent to the living tissues. As a matter of fact, however, it is probable that every cell and fluid in the body has its specific osmotic pressure, with a consequent variation in the concentration of the sodium chloride solution isotonic with it. The active tissues of the body contain a very large proportion of water, and physical continuity between these media is established by the inter-cellular and intra-cellular lymph. It would naturally be supposed, and experiment has shown this to be the case, that the normal distribution of water between the blood, lymph and solid tissues is maintained through the nicest physiological adjustment, the direct working factor of which is probably the force of **osmosis.** When the blood loses water, this is replaced by fluid drawn from the lymph, which in turn makes good its loss from the solid tissues. When a dilute solution of sodium chloride which has a lower osmotic pressure than the blood is introduced in excess into a vein, the hydræmic plethora thus produced begins at once to diminish, owing to the rapid transudation of the fluid through the capillary walls, not of the muscles, but of the intestine and peritoneum. In the interchange of bodily fluids, however, the forces of filtration and diffusion complicate those of osmosis in the transference of material. For the occurrence of osmotic interchange the separating membrane must be permeable to water, but impermeable to substances dissolved in it; and the capillary wall, which separates the blood from the lymph, is not of this character, since through it there may take place both filtration due to difference of hydrostatic pressure and diffusion of substances in solution. The laws of osmosis have been thus summarized: (1) Solutions separated by a membrane permeable to water tend to have an identical molecular composition. (2) If the membrane is perfectly permeable to both solvent and dissolved substance the exchange of molecules will take place without change in pressure or volume. (3) If the membrane is less permeable to the dissolved substance than to the solvent, an increase of liquid, or increase of tension, will occur in the stronger solution. (4) If a membrane is differently permeable to one dissolved substance than to another, equimolecular solutions of the less diffusible substance will be hyperisotonic (hypertonic) to the more diffusible.

In the mouth and fauces strong solutions of sodium chloride have an astringent action, while in the stomach they may have an emetic effect from the irritation caused by the withdrawal of fluid and the impartation of salt to the mucous cells. They are also capable of exerting a purgative action. A small amount of sodium chloride in the food, by rendering the latter more palatable, no doubt often has the effect of increasing the flow of gastric juice through reflex influence; but it would seem that stomachic digestion is not always improved by it, since it has been found that even small quantities diminish the acidity of this secretion. Mineral waters in which common salt is the chief constituent have no direct effect on the secretion, but appear to alter the nutrition of the gastric mucous membrane. Thus it is found that in some individuals the hydrochloric acid is increased by these waters, while in others it is lessened. Hypertonic and isotonic salt solutions are absorbed in the stomach and intestine, as well as hypotonic ones, and in order to explain this it is necessary to assume that there exists a constant natural tendency for fluids and some salts to pass inwards from the lumen of the gastro-intestinal tract. Hypotonic solutions are naturally absorbed rapidly, while isotonic ones are absorbed more slowly, because in their case the natural flow alone is active. With hypertonic solutions the absorption is still slower, for the reason that the natural flow is at first antagonized by the osmotic pressure-current, which is in the opposite direction. Hence, for a time the fluid in the canal may actually be increased, by the abstraction of liquid from the blood; but, as the absorption of salt is all the while taking place, the concentration of the fluid is gradually reduced until it becomes isotonic, and it is then absorbed. In the serous cavities it is stated that when salt solution is injected, absorption takes place in the same way as from the stomach and intestine, except that osmosis plays a more important part than in them. The blood and lymph are in turn affected by the processes occurring in the alimentary canal, and while the details of the changes which take place between these are not clearly understood, it is established that the absorption of salt, as well as of water, leads to an augmentation of the normal exchange of the two fluids. Again, the changes in the blood and lymph are followed by an increased activity of the excretory organs. The flow of urine is increased to some extent by the absorption of salt solution from the alimentary canal, and to a notable degree by the injection of such a solution into the circulation, and this is believed to be the result of salt-action, and not of any direct effect produced upon the renal cells. The saliva is also increased, partly by a reflex from the mouth and partly because a portion of the salt is excreted by the salivary glands. While any salt solution causing an acceleration in the movement of the fluids of the body necessarily tends to facilitate the excretion of waste products, the elimination thus caused is much smaller than has generally been supposed to be the case, and recent investigations indicate that salt tends to lessen the proteid metabolism through acting directly on the cells. This action is stated to be so slight, however, that the resulting fall in the nitrogen eliminated is concealed by the increase caused by the more complete flushing. Both sodium chloride and the potassium salts augment the salts of the urine. While carnivorous animals and hunting peoples require no salt and often have a distaste for it, in consequence of their food containing so large a proportion of sodium salts, common salt forms an important article of diet with all creatures living largely or exclusively on vegetable food, in whom the potash in the food causes an intense craving for it. The cause of this desire for salt has been explained as follows: Blood plasma contains much sodium chloride, vegetable foods contain a large amount of potassium salts; when, therefore, these salts of potassium reach the blood, potassium chloride and the sodium salt of the acid which was combined with the potassium are formed. This and the potassium chloride are excreted by the kidneys, and the blood loses its sodium chloride, which loss is therefore made up by taking sodium chloride with the food. Some doubt is said to have been recently thrown on this explanation by the discovery of certain African tribes living on vegetable substances alone, and yet using the ashes of plants, which contain more potash than soda, as civilized peoples use ordinary salt. As sodium chloride is the most important of the mineral constituents of the body, so far as regards its general distribution and the active part which it takes in the internal phenomena of nutrition, the ingestion of an adequate amount of it is essential to the maintenance of health, and the deprivation of it leads to general weakness, œdema and anæmia.

THERAPEUTICS OF SODIUM CHLORIDE.

Locally it is used to limit the action of silver nitrate when applied to mucous membrane, as a gargle in ordinary sore throat or in atomized solution in subacute and chronic affections of the pharynx and larynx, in douches for the treatment of nasal catarrh and ozæna, as an injection for the vagina and rectum, and as a wash for indolent ulcers, hives and pruritus vulvæ, as well as for the stings and bites of insects. As a rule, the solution used for affections of the mucous membrane should not exceed a strength of 1.20 gm. (20 gr.) to 500 c.c. (1 pint) of water, as stronger solutions are likely to be painful and to aggravate the disease. Rectal injections of strong solutions of salt, which by removing mucus serve to render the bowel unfit for the habitation of the parasite, constitute one of the best methods of treatment for the *Oxyuris vermicularis*. A solution of it in whiskey is a popular remedy for muscular rheumatism and for bruises, sprains, glandular swellings, etc., and hot salt enclosed in bags is a good application in lumbago and other forms of myalgia and in colic, dysmenorrhœa, toothache and other painful conditions. In the strength of ½ per cent. it makes an invigorating as well as cleansing bath, and in a 5 per cent. solution has been recommended as more agreeable and useful than soap baths in subacute eczema, psoriasis, etc. Concentrated hot salt baths, like those of Droitwich and Nantwich, are beneficial in chronic rheumatism and sciatica. Sea-bathing, as is well known, has a pleasant general stimulating effect, and its beneficial results are largely due to the abundant presence of sodium chloride in the water.

Internally it is used at times as an emetic, and from 15 to 30 gm. (1 to 2 tablespoonfuls) in 250 c.c. (½ pint) of tepid water are generally successful in causing a prompt evacuation of the stomach. Its efficiency as an emetic is increased by combining it with mustard water. In poisoning by silver nitrate it arrests the corrosive action by the formation of insoluble silver chloride. Administered in the form of natural mineral waters, in which it is a prominent ingredient, or in carbon dioxide water, it often proves of service in gastric disorders, and especially dyspepsia attended with decomposition of food in the stomach, with resulting flatulence, acidity and pain. Salt meat, olives and other saline articles tend to prevent alcoholic intoxication, and enemata of salt and water are employed with success to rouse drunkards from their lethargy or abate their delirious outbreaks. In conditions where the body has lost much fluid, as from hæmorrhage and in Asiatic cholera, life has repeatedly been apparently saved by the intravenous injections of solutions of salt in distilled or boiled water, with the addition sometimes of a small amount of sodium sulphate or carbonate, calcium chloride, or other alkali; and normal saline solution is now commonly given in this way or by hypodermatoclysis (*see* p. 3), as a substitute for transfusion of blood. This may be prepared by dissolving 4 gm. (60 gr.) of common salt in 500 c.c. (1 pint) of boiling water, and allowing the solution to cool to 37.7° C. (100° F.). It is often desirable, however, to use it at a considerably higher temperature than this. Recently an effort has been made to secure a solution which might be free from the disadvantages found in the actual use of saline infusions whether used by the intravenous method, by hypodermatoclysis or by injection into the peritoneal cavity. Although its content of sodium chloride is higher than that given above the following has been lately recommended: Sodium chloride, 0.9; calcium chloride, 0.026; potassium chloride, 0.01; distilled water, 99.064. Salt solution has also been employed in uræmia and similar intoxications, and in such conditions subcutaneous injection is preferred by some. In the case of insane patients who refused to take food the use of salt solution by hypodermatoclysis has sometimes been found of service, as it has the effect of exciting hunger and thirst. In poisoning by carbon dioxide and by coal gas good results have been reported from this procedure or the intravenous injection of a salt solution, after a preliminary bleeding. Intestinal lavage with normal saline solution, by means of the rectal irrigator, is almost certain to have a marked diuretic effect, as it has been pointed out that the association of action between the lower bowel and the kidneys is such that a movement of the bowels can scarcely take place without simultaneously inducing a urinary flow. It is therefore of great service in various conditions, and especially acute nephritis. In colitis, particularly when chronic, medicinal remedies not infrequently fail to complete the cure until supplemented by the local effects of such lavage. The beneficial influence of the enteroclysis may be enhanced by the addition to the fluid of antiseptic and anodyne agents. Auto-infection from retention of putrid contents in the colon may give rise to grave cerebral symptoms, and the same conditions are often met with in cholera infantum; here such intestinal irrigation is indicated, both to combat the toxic infection and to secure the beneficial effects of the saline on the blood, after it has been drained of its salts by the watery evacuations. This procedure may also prove valuable against the toxæmia in fevers, particularly typhoid fever.

8. **SODII NITRAS.**—Sodium Nitrate. **Dose, 1 gm. (15 gr.).**

Action of Sodium Nitrate.

Its action is practically the same as that of potassium nitrate, except that it is much less depressant to the heart. In dilute solution it may be taken in large amount without producing any effect except diuresis. It is a less efficient diuretic than potassium nitrate, however, as it lacks the stimulating influence upon the kidney which is due to the potassium constituent of the latter salt. In concentrated form it acts as a gastro-intestinal irritant and may cause purgation, with the result of lessening the force or frequency of the heart's action and of lowering the temperature.

Therapeutics of Sodium Nitrate.

At the present day it is very rarely employed in practical medicine. Formerly it was chiefly used in diarrhœa and dysentery, in daily doses of from 30 to 60 gm. (1 to 2 oz.) dissolved in a large quantity of water. It has been considered of service in relieving maniacal excitement, in daily quantities of from 3 to 5 gm. (45 to 75 gr.), and in two patients who suffered from epilepsy of psychical origin it is said that the attacks could be prevented by the exhibition of 6 gm. (1½ dr.) immediately after the appearance of the aura.

9. **SODII ACETAS.**—Sodium Acetate. **Dose, 1 gm. (15 gr.).**

ACTION OF SODIUM ACETATE.

The same as potassium acetate, both resembling the chlorides and therefore owing any effect they possess to the salt-action. In the body, however, they are oxidized, with the formation of carbonates, and hence their action before absorption is that of the chloride, and afterwards that of the carbonate. The result is that the alkalinity of the blood and of the urine, as well as the amount of the latter, is increased. A mixture of equal parts of sodium acetate and potassium nitrate explode with great violence.

THERAPEUTICS OF SODIUM ACETATE.

It is employed principally to yield acetic acid by the action of sulphuric acid, and although it has decided diuretic properties, is seldom prescribed medicinally. By some, however, it is considered more efficient as a diuretic, as well as milder and less apt to derange the digestion, than potassium acetate. It has been given as an antacid in acute rheumatism and as a diuretic in dropsies, and also used in irritation of the genito-urinary apparatus and gout.

10. **SODII CHLORAS.**—Sodium Chlorate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF. SODIUM CHLORATE.

Practically the same as that of potassium chlorate.

THERAPEUTICS OF SODIUM CHLORATE.

It has never been used to anything like the extent of the potassium chlorate, but is occasionally employed as a substitute for the latter in affections of the mouth and throat. Its greater solubility, it may be said, permits of stronger solutions. As a gargle or wash a 2 to 5 per cent. solution may be prescribed. It has been used with asserted remarkable results in cancer of the stomach, but the large doses employed would seem to be attended with considerable danger from chlorate poisoning.

11. **SODII PYROPHOSPHAS.**—Sodium Pyrophosphate. **Dose, 2 gm. (30 gr.).**

ACTION OF SODIUM PYROPHOSPHATE.

Sodium pyrophosphate has the same therapeutical action as sodium phosphate.

THERAPEUTICS OF SODIUM PYROPHOSPHATE.

Its principal use is in pharmacy, and it is rarely, if ever, employed as a medicine.

12. **SODII CITRAS.**—Sodium Citrate. **Dose, 1 gm. (15 gr.).**

ACTION OF SODIUM CITRATE.

It is a cooling and mild purgative, similar in its action to magnesium citrate.

THERAPEUTICS OF SODIUM CITRATE.

It may be given in cases where a pleasant saline laxative is required.

13. **Sodii Æthylas** (not official).—Sodium Ethylate.

ACTION OF SODIUM ETHYLATE.

When it is applied to living tissues the following effects have been observed: 1, a removal of water from the tissue; 2, the destructive action of the resulting caustic soda; 3, coagulation from the alcohol that is reproduced; 4, prevention of decomposition in the resulting dead tissue. It is stated that the liberated alcohol coagulates the albuminous compounds in its neighborhood, and thus limits the caustic action of the soda, and that the red blood-corpuscles become disintegrated, and then crystalline, while the white are for a time unaffected. When used for local pathological conditions it affects the surrounding healthy skin to but a slight extent, its action being restricted to the spot on which it is applied; and it produces scarcely any scarring. As compared with the action of nitric acid, there is but little destruction of the epidermis, while the pain caused by it is less severe than that from the acid.

THERAPEUTICS OF SODIUM ETHYLATE.

It is used exclusively for its local effects, and is by some considered the best of all caustics. Its corrosive action is very speedy and energetic, and it has been employed especially for the destruction of nævi. It is customary to apply it, by means of a glass rod, for two or three days successively, and when the eschar thus formed has fallen off the treatment is repeated, if necessary. The pain caused by it may be mitigated by mixing it with laudanum, and in pendulous vascular tumors the risk of too great hæmorrhage may be avoided by diluting the ethylate with alcohol, so as to promote coagulation. This caustic is also used with advantage in a variety of other conditions, such as tattoo, hypertrichosis, warts, moles, callous ulcers, nasal polypus, hæmorrhoids, lupus, epithelioma, and melanotic growths. Sodium ethylate has also been employed in ringworm and other skin affections. Applied directly to the unbroken skin, it is asserted that its destructive action is less painful than would be expected, and that when pain is felt it may be quickly checked by dropping a little chloroform upon the part.

AMMONIUM.

1. **AQUA AMMONIÆ FORTIOR.**—Stronger Ammonia Water.

Preparation.

Spiritus Ammoniæ.—Spirit of Ammonia. **Dose, 1 c.c. (15 ♏).**

2. **AQUA AMMONIÆ.**—Ammonia Water. **Dose, 1 c.c. (15 ♏).**

Preparations.

1. **Linimentum Ammoniæ.**—Ammonia Liniment. (Volatile Liniment.)

2. **Spiritus Ammoniæ Aromaticus.**—Aromatic Spirit of Ammonia. **Dose, 2 c.c. (30 ♏).**

ACTION OF SOLUTIONS OF AMMONIA.

External.—Applied to the skin ammonia solutions of moderate strength are **rubefacient.** Strong solutions cause a sensation of burning pain and, if the part is covered, will give rise to **vesication.** Ammonia differs from the other alkalies in being more volatile, in consequence of which it penetrates more rapidly and deeply. It passes through the *stratum corneum* of the epidermis without dissolving it, and produces the blisters by its action on the lower layers of the skin. At the same time it is less corrosive and less enduring in its effects than the fixed alkalies, although, if the application is continued sufficiently long, sloughing will result.

Internal. *Eyes, Nose and Air Passages.*—Vapor of ammonia, in contact with the eye, causes severe pain and inflammation. When inhaled it is also irritating, occasioning smarting, sneezing, lachrymation and coughing, with reflex acceleration of the pulse and respiration. If sufficiently concentrated, it is likely to cause spasm of the glottis or such swelling of the mucous membrane of the larynx and trachea as to induce asphyxia. Animals immersed in such vapors become asphyxiated, and 5 parts of ammonia in 10,000 are considered dangerous.

Stomach.—In the mouth, fauces, œsophagus and stomach concentrated solutions produce corrosions similar in character to those resulting from caustic potash and soda, but as the gas evaporates rapidly from ammonia solutions, some of the vapor generally escapes into the respiratory passages, and in the manner described tends to produce asphyxia, which may result in death very suddenly. In dilute solution ammonia acts as a mild gastric stimulant. Like other alkalies, it renders the gastric juice less acid and tends to liquefy the mucus in the stomach.

Skin, Mucous Membrane, and Salivary Glands.—Ammonia and its salts have considerable effect in increasing the secretions, especially the saliva, mucus and perspiration. The diaphoresis has been attributed to their action on the central nervous system, and the increase in the saliva and mucus to a reflex stimualtion from mucous membranes due to a salt action, to direct stimulation of the secreting centres, and to local salt-action upon the secretory cells themselves. It is considered doubtful, however, whether these agents, although having a direct action upon the central nervous system when injected into the circulation, are capable of producing any such effect when they are absorbed from the stomach. The ammonium salts are said to be excreted largely into the mouth by the saliva, as also by the lungs, mainly in the form of carbonate. In this way the local action is exerted twice (when the salt is applied and when it is excreted), and this excretion in the form of carbonate also tends to liquefy the mucus on account of the alkaline action.

Blood.—Little is known of the behaviour of ammonia in the blood, although when injected in poisonous quantities it has been found to prevent the blood from taking up oxygen. It was at one time supposed by some observers that the coagulation of the blood was caused by the escape of ammonia, but it is now known that this is not the case. Still, ammonia helps to maintain the fluidity of the blood, while its presence, in sufficient quantity, serves to hold the fibrin in solution. Thus, having the property of dissolving fibrin, it is believed to diminish the local liability of the blood to coagulate, and also to be capable of dissolving clots, in cases of thrombosis.

Heart and Circulation.—Upon the circulation ammonia acts as a powerful, but fleeting **stimulant**. When it is inhaled, the irritation of the nasal mucous membrane causes a reflex stimulation of the vaso-motor centre, and consequent constriction of the arterioles and **increased blood-pressure**. The cardiac action may be temporarily slowed by inhibitory reflexes. Also when ammonia is injected in moderate amounts into the circulation, the blood-pressure rises from the contraction of the peripheral vessels caused by stimulation of the vaso-motor centre. The heart itself is sometimes slowed from increased activity of the inhibitory centre, and sometimes accelerated; whether in consequence of action on the cardiac muscle or on the acceleration centre is not known. The pulse-rate and the pulse-force, as well as the blood-pressure, are usually increased, and the rise in the arterial pressure is followed, if the dose has been sufficiently large, by a decided fall, ending in permanent diastolic arrest of the heart. If by means of intravenous injection the ammonia reaches the heart in large amount in concentrated form, the organ at once ceases to beat, in consequence of paralysis of its muscular walls. Any effect that solutions of ammonia, when taken by the mouth, may have in stimulating cardiac action, is probably not due to a direct influence upon the heart, but to an action exerted reflexly from the gastric irritation.

Respiration.—From the reflex stimulation of the respiratory centre in the medulla, when ammonia is inhaled, the respiration is at first checked, and then rendered fuller and deeper. So, when the drug is injected subcutaneously or intravenously the respiration often ceases for a moment, and then becomes very much accelerated, while in some instances it is deepened; this increase in respiration being due to **stimulation of the respiratory centre.** As to the preliminary pause, it has been attributed by some to action on the vagus terminations in the lungs, while this is denied by others, and it is thought probable that it is due simply to excessive stimulation of the respiratory centre. The breathing finally stops in respiratory tetanus.

Nervous System and Muscles.—The action on the central nervous system consists of a **stimulation,** especially of the **medulla oblongata** and **spinal cord.** According to some observers the brain is found to be rather depressed, so that there is somnolence. Others believe that the brain is first stimulated, and that this action inhibits the reflexes. Then, as the stimulation passes downwards, the spinal cord is acted on in turn, and the reflexes are exaggerated. The rise of arterial pressure and the quickening of the respiration, from the action on the medullary centres, have already been mentioned. When the drug is injected into the circulation tetanic convulsions may occur, though appearing rather late, and they resemble strychnine spasms quite closely. As they persist after division of the cervical cord and destruction of the brain and medulla oblongata, they would appear to be due to changes in the spinal cord such as are observed in poisoning by strychnine. During the convulsions the respiration is arrested and the blood-pressure becomes extremely high. If the amount injected into the circulation be sufficiently large, the stimulation is followed by paralysis of the central nervous system, and death is caused by asphyxia. The muscles are acted on by ammonia in much the same way as by potassium, although it is stated that a preliminary stage of augmented irritability not met with in the case of the latter has been observed by some investigators. Under the effects of potassium the contraction of the muscle of the frog appears to be somewhat greater in height, though shorter in length, while there is less tendency to contracture; and muscle exposed in a solution of potassium chloride dies very much sooner than in an isotonic solution of sodium chloride.

Kidneys.—Ammonia differs from the fixed alkalies in not increasing the alkalinity of the blood and in not reducing the acidity of the urine or rendering it alkaline. This is because it is changed to urea in the body, and is excreted in this form in the urine. The flow of urine is sometimes, but not always, increased by the administration of the salts of ammonia; when this is the case it is said to be due simply to the increase of urea.

THERAPEUTICS OF SOLUTIONS OF AMMONIA.

External.—The stronger water of ammonia is sometimes used as a rubefacient and vesicant. This solution, however, will generally be found too strong for use in its unmixed state, and where a prompt and sufficiently powerful counter-irritant effect is indicated, as is sometimes the case in various neuralgic, gouty, rheumatic, spasmodic and inflammatory affections, it may be combined, in the proportion of five parts to eight, with a diluent liquid composed of spirit of camphor and rosemary. If a very quick effect is called for, the proportion should be five to three. A convenient method of application is to fill the cover of an ointment-box, or other suitable receptacle, with lint, and, having saturated it with the lotion, press it upon the part. The ammonia is thus prevented from escaping, and a definite boundary given to the action desired. The less diluted mixture will generally produce rubefaction in from one to eight minutes, and vesication in from three to ten minutes. In severe neuralgias the skin may be blistered at points where the affected nerve is found to be tender. Care should always be taken, however, that the application should not be continued too long, as sloughing may then result. A salt of morphine may be added to the solution employed. In some cases "thimble-blistering" is advised; in which small areas over the painful spots are vesicated by means of undiluted stronger water of ammonia dropped upon absorbent cotton and confined with a thimble or watch-glass in contact with the skin. Ammonia is not often used for epispastic purposes, as the blisters produced by it are more painful and slow to heal than those of other vesicants. It is especially applicable, however, when vesication is desired in cases of renal disease, in which cantharides is contra-indicated. Aqua Ammoniæ is a very good application for the stings and bites of insects. The stronger water is often applied in snake-bite, but so far as any antidotal action is concerned it would seem to be of no service, as ammonia has been shown to have no effect on the toxalbumins of snake-poison. The inhalation of Aqua Ammoniæ is of great value in cases of syncope; held to the nostrils of persons who have fainted, by its effect on the mucous membrane, it usually produces, through reflex influence, very prompt stimulation of the heart and respiration. In all cases of suspended animation, whether from syncope or asphyxia, it may be employed, but with caution, on account of the possibility of its giving rise to inflammation of the fauces, glottis and larynx. Ammonia is the basis of most of the "smelling salts" in popular use, the ordinary form of which consists of the carbonate reinforced with some of the strong solution of ammonia and flavored with oil of lavender. Ammonia water is much used in liniments, usually combined with olive or other oil, and also in washes to prevent the hair from falling out or to stimulate its growth. Amenorrhœa, as well as leucorrhœa, is said to have sometimes been successfully treated by vaginal injections of a weak solution of ammonia Such solutions have also been used in the treatment of superficial burns and frost-bite, and, in association with hot water, for sponging the surface for the relief of general exhaustion or depression of the nervous system in low fevers. The early inhalation of dilute vapor of ammonia may perhaps sometimes arrest the development of catarrhal affections of the throat and air-passages, and also prove of service in chronic dryness of the pharynx and chronic hoarseness. It has been known, it is said, to delay or prevent the paroxysms of whooping-cough and epilepsy.

Internal.—In the stomach ammonia in solution acts as a stimulant antacid, and is useful in heart-burn, sick-headache, etc., but in dyspeptic conditions it is not used alone so much as in combination with the carbonate in the Spiritus Ammoniæ Aromaticus. In sudden paralysis of the heart from chloroform narcosis, poisonous gases, or toxic agents such as hydrocyanic acid, nicotine, etc., or in collapse from any cause, it may be intravenously injected—4 to 8 c.c. (1 to 2 fl. dr.) of Aqua Ammoniæ with an equal quantity of water. Injected subcutaneously, it almost invariably produces a slough. Intravenous injections of ammonia are also called for when sudden thrombosis of a large venous trunk occurs, as, for example, in the pulmonary artery, after uterine hæmorrhage. They may even be employed when thrombosis is threatened, but has not actually taken place, as in the puerperal state, after free hæmorrhage, when the circulation is depressed from weak heart. In chloroform narcosis this procedure not infrequently fails, and the reason for this is believed to be because the heart stops suddenly and completely, so that before the injection can be practiced the cardiac ganglia have entirely ceased to functionate. The opinion has been expressed that failure has sometimes resulted in other classes of cases because a sufficient quantity of ammonia was not employed, and a case is on record in which a patient is stated to have been saved from inevitable death from the effects of the gases of a privy vault by no less than twelve intravenous injections of the stronger water of ammonia, the whole amount thrown into the circulation being 8.6 c.c. (140 ♏). The repetition of the injection should naturally depend on the effects noted, and it is advised that the limit to the amount of ammonia used should be determined by the state of the heart. Notwithstanding the negative results obtained in experimental researches, many instances have been reported in which ammonia injections seemed to be efficacious in poisoning by venomous serpents. In such cases the beneficial results were no doubt due to the prompt and energetic stimulation, rather than to any antidotal value of the remedy.

3. **AMMONII CARBONAS.**—Ammonium Carbonate. (Bakers' Ammonia. Hartshorn. Sal Volatile.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

> **Elixir Ferri, Quininæ et Strychninæ Phosphatum.**—Elixir of Iron, Quinine and Strychnine Phosphates. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF AMMONIUM CARBONATE.

The pharmacological effects of the carbonate are similar to those of solutions of ammonia. Although not so corrosive as the latter, when swallowed in sufficient quantity it acts as an irritant poison. Slight gastric irritation is produced by moderate amounts, and nausea and vomiting by larger doses. It has **expectorant** properties of great value, as it not only increases the bronchial mucous secretion and renders it more fluid, but reflexly stimulates the respiratory centre in the medulla oblongata. In the urine it is excreted as urea.

THERAPEUTICS OF AMMONIUM CARBONATE.

The carbonate, either in solution, or in the form of aromatic spirit of ammonia, is given very frequently in cases of collapse and heart-failure, or where such conditions are threatened. Here the stimulating influence exerted by it is probably not, as has been generally supposed, directly upon the heart and respiratory centre in the medulla, but a reflex effect resulting from the gastric irritation. When thrown into the circulation, however, either by subcutaneous or intra-venous injection, there can be no question that it has a direct action upon the medullary centres, and thus causes a powerful, though evanescent, stimulation. In less serious depression resulting from various causes Spiritus Ammoniæ Aromaticus is a favorite remedy, and generally answers very well for temporary purposes; giving a feeling of increased strength, or even of exhilaration, and increasing the warmth of the surface. It is useful as a gastric stimulant and carminative, and is employed especially in cases of headache attended with acidity of the stomach and flatulent eructations. It is also of service in the acid stomach and tympanites met with particularly in hysterical women, and will sometimes prevent or abort paroxysms of hysteria. In nervous headaches, whether attended with nausea or not, it often affords relief. Ammonium carbonate is likely to prove successful in the treatment of delirium tremens when the latter is associated with cerebral anæmia and weak heart action. It sometimes counteracts even a high degree of alcoholic intoxication, and is serviceable in the dyspepsia of drunkards from its stimulant and antacid properties, as well as its action in dissolving the tenacious mucus coating the stomach. In doses of from .30 to .60 gm. (5 to 10 gr.), administered with .60 c.c (10 ♏) of tincture of capsicum in 30 c.c. (1 fl. oz.) of some bitter infusion, it is very efficient in relieving the sinking sensations and craving for stimulants experienced by subjects of alcoholism. It is a valuable cardiac and nervous stimulant in syncope, heart-exhaustion, and all typhoid conditions, and may therefore at times be employed with advantage in adynamic forms of pneumonia, scarlet fever, measles, small-pox and erysipelas, as well as in typhus and typhoid fevers. As it is quickly eliminated, it is best given in small doses repeated at short intervals. By some, however, its administration in typhus and typhoid fevers has been regarded as improper, on the ground that in these diseases the ammonia in the blood is increased beyond the normal. In pneumonia it has been pointed out that to stimulate the heart merely, when an obstacle exists in the pulmonary circulation, is of doubtful utility; but ammonium carbonate, by liquefying the exudation, also relieves obstruction of the bronchial tubes, and is thus a remedy of great value. It is sometimes prescribed with good effect in infusion of senega, which is a stimulant expectorant. In bronchitis and broncho-pneumonia it is often given in association with other expectorants, and is perhaps most used in the case of children and old people. It is especially esteemed in the capillary bronchitis of the young, and is employed by surgeons in the treatment of children after operations to overcome the respiratory and circulatory depression produced by the anæsthetic. In rather large and frequently repeated doses it may prove efficacious in aborting a cold. On account of its alkalinity, ammonium carbonate should not be prescribed in a mixture with either the vinegar or syrup of squill, the latter being made from the vinegar. It is sometimes used as an emetic, in doses of 2 gm. (30 gr.) for an adult, and is less depressant than many other agents employed for this purpose. In diabetes it has been thought to sometimes prove of service, and its use has been strongly recommended in the treatment of cystinuria.

4. **AMMONII CHLORIDUM.**—Ammonium Chloride. (Sal Ammoniac. Ammonium Muriate.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Trochisci Ammonii Chloridi.—Troches of Ammonium Chloride.

ACTION OF AMMONIUM CHLORIDE.

Applied locally to mucous membranes, it stimulates their secretion. After absorption it also acts upon these membranes, rendering the secretions of the stomach and the bronchial mucous membrane less tenacious, as well as increasing their amount. Injected into the circulation, it has, like ammonia and its carbonate, a stimulating action on the central nervous system, but when absorbed from the alimentary canal it apparently has no such direct effect, though reflexly it may cause some stimulation. When swallowed in considerable quantity it may induce irritation and vomiting, but only through its action as a salt. Solutions of the chloride are rapidly absorbed from the stomach and intestine, and permeate the red blood-corpuscles with great facility. It apparently has some action on the liver, and it is thought probable that this is explained by its increasing the excretion of urea by the kidneys. In the body it is changed to urea, and this transformation seems to take place principally in the liver. When urea is formed from it hydrochloric acid is liberated in the tissues, and this, it is stated, would act as a poison, were it not neutralized at once by ammonia being formed in the tissues themselves. It seems to have some effect in increasing the urine, as well as the secretion of the salivary and sweat glands. It is said to be excreted to some extent by the salivary glands, but its elimination takes place principally by the kidneys.

THERAPEUTICS OF AMMONIUM CHLORIDE.

In consequence of its decided action on mucous membranes, ammonium chloride (either in its nascent state, as generated by the action of hydrochloric acid on ammonia, or in the form of an atomized watery solution), is largely used by inhalation in pharyngitis, otitis media, laryngitis, bronchitis, etc., and especially when these conditions are chronic. In both acute and chronic pharyngitis and bronchitis it is frequently administered in the form of troches or compressed tablets. It is also a favorite ingredient of expectorant mixtures. Combined with potassium iodide, tincture of ipecacuanha, and brown mixture, it is regarded as of special value in acute catarrhal pneumonia. It is sometimes employed with good effect in so-called biliousness, with coated tongue, decreased secretion of the intestinal juices, scanty, high-colored urine, etc., and in various hepatic affections, such as chronic torpor of the liver, chronic hepatitis, and catarrh of the bile-ducts with jaundice, it is often of great service. In the first stage of cirrhosis it has also been found useful by some authorities. The disagreeable taste of the drug may be covered to a considerable extent by licorice or by the fluidextract of taraxacum. The former would naturally be preferred as a vehicle for affections of the respiratory apparatus, and the latter in hepatic disorders. In these, taraxacum is used by many practitioners, although it would appear that there is no sufficient ground for the belief that it has a specific action on the liver. Formerly ammonium chloride was sometimes given in malarial fever, and large doses of it have been recommended in neuralgia. By those who have found it useful it is believed to be chiefly serviceable in neuralgias depending upon cold, and tincture of aconite has sometimes been associated with it. It has also been thought beneficial in myalgia and chronic muscular rheumatism. Like the other preparations of ammonia, it is employed in acute alcoholism, and 2 gm. (30 gr.) in 250 c.c. (½ pint) of water, swallowed at one draught, is said to be sometimes remarkably efficient in the case of patients on the verge of delirium tremens. By some it is considered a very useful remedy in the subacute gastric and intestinal catarrh of children, in doses of from .12 to 1 gm. (2 to 15 gr.), preferably given with licorice and water to mask the taste. It is also beneficial in some cases of gastric catarrh in adults, and .60 gm. (10 gr.), given half an hour before meals, it is asserted, will afford extraordinary relief in painful dyspepsia due to hyperacidity of the stomach. In tropical dysentery good results have been reported from its use. When this remedy is administered in the form of compressed tablets it is advised that a large draught of water or milk be taken simultaneously to protect the stomach. The local application of ammonium chloride is not resorted to at the present time to such an extent as was formerly the case. Its stimulating action has been made use of to arrest the progress of gangrene, especially of the senile variety; cataplasms or local baths containing it being applied according to the situation of the disease. In weak solution it has been employed as a wash for ulcers and a vaginal injection for leucorrhœa, and in stronger solution as a stimulant and resolvent in contusions, contused and lacerated wounds, sprains, enlarged bursæ and joints, indolent tumors, etc. A solution of from 8 to 15 gm. (2 to 4 dr.) to 500 c.c. (1 pint) of water removes ecchymosis from contusions, and is also applicable to subacute epididymitis. In local inflammations the cold produced by it in dissolving may sometimes be taken advantage of. Five parts of ammonium chloride with 5 parts of potassium nitrate and 16 parts of water will cause a very considerable lowering of the thermometer. It forms a useful ingredient in errhine powders, and a solution of 8 gm. (2 dr.) to 120 c.c. (4 fl. oz.) of water is an efficient topical application in rhus poisoning.

5. **LIQUOR AMMONII ACETATIS.**—Solution of Ammonium Acetate. (Spirit of Mindererus.) **Dose, 16 c.c. (4 fl. dr.).**

ACTION OF AMMONIUM ACETATE.

Locally the acetate acts in the same way as the chloride, but in the tissues it undergoes oxidation and the whole of it is converted into urea; so that while the urea of the urine is increased, there is no increase in its ammonia. In the case of the chloride, the net result of the effects produced upon the system is that the urea excretion is but little changed, while the ammonia of the urine is much increased. Ammonium acetate causes an increase not only of the solid constituents of the urine; but also of its fluid, and it stimulates the secretion of the **skin** as well as that of the **kidneys**.

THERAPEUTICS OF AMMONIUM ACETATE.

On account of its diaphoretic and diuretic properties, it is sometimes prescribed in fever, either alone or together with more powerful remedies. In typhoid fever, however, it has been found that the diarrhœa may be increased by it. It used to be given very frequently combined with spirit of nitrous ether, and in mild febrile conditions in children is still employed to some extent thus associated. Solution of ammonium acetate sometimes proves very grateful to fever patients when administered with an equal quantity of carbon dioxide water. In sick headache from 4 to 8 c.c. (1 to 2 fl. dr.) repeated every hour, is often very efficacious, and this remedy may also be used with good results in acute alcoholism. It is sometimes given as a substitute for alcohol in pneumonia, proving useful as a mild stimulant. As a diuretic it is employed as an adjuvant in the treatment of scarlatinous dropsy and of chronic Bright's disease.

LITHIUM.

1. **LITHII CARBONAS.**—Lithium Carbonate. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

2. **LITHII CITRAS.**—Lithium Citrate. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Lithii Citras Effervescens.—Effervescent Lithium Citrate. **Dose, 8 gm. (120 gr.).**

ACTION OF LITHIUM CARBONATE AND CITRATE.

Lithium is believed to possess an action midway between sodium and potassium, but comparatively little is known of the physiological effects of its salts. When given to dogs by the mouth in sufficient quantity they have been found to produce severe gastro-intestinal irritation, with diminished secretion of bile. Injected into mammals they have caused marked weakness, gastric disturbance, diuresis, increasing dyspnœa, fall of temperature, and death (often preceded by convulsions), from arrest of the respiration. The heart of the frog is arrested in diastole, but lithium acts much less powerfully on the mammalian heart than potassium. It appears to be depressant to the motor nerves, as well as the spinal cord, and to weaken muscular contraction. These salts in medicinal doses rarely give rise to any definite symptoms in man, unless it be an increased flow of urine, but large quantities may cause gastric derangement and possibly some muscular twitching. In the body, lithium slightly increases the nitrogen excretion. The citrate is less disagreeable to the taste and less liable to irritate the stomach (though in occasional instances it produces nausea and vomiting) than the carbonate, and its effects are the same, as the citric acid is consumed in the system and a lithium carbonate formed and excreted in the urine. Lithium salts are capable of rendering the **urine** very **strongly alkaline**.

THERAPEUTICS OF LITHIUM CARBONATE AND CITRATE.

Lithium salts are useful alkaline remedies, and are employed to a considerable extent in the treatment of rheumatism and gouty affections, especially of a subacute and chronic character. They have been much lauded in the so-called uric diathesis, but while outside the body lithia exhibits great solvent power over uric acid, with which it forms a biurate which is more soluble than the corresponding salts of the other alkali metals, it has been pointed out that in the system it has a greater affinity for the acid sodium phosphate in the blood, and practically leaves the uric acid to itself. There is unquestionably a large amount of clinical evidence going to show the beneficial effects of lithium salts in gouty cases and where there is a tendency to uric acid, sand and gravel; but there is reason to believe that in the body fluids the amount of lithium introduced by ordinary dosage can exercise no solvent influence upon gouty deposits, and it is now the opinion of many of the best authoricaused by the prolonged use of considerable amounts of magnesium oxide.

THERAPEUTICS OF MAGNESIUM SALTS.

Magnesium oxide and carbonate are used as mild **antacid laxatives.** They are favorite remedies in sick headache, especially when accompanied by acidity and constipation, and in the digestive derangements of children. For the correction of acidity the carbonate is preferable if gastric irritability is present, as the carbon dioxide which is set free by the action of the acid met with in the stomach serves as a local sedative and anodyne. If these preparations do not enter into combination with the stomach acid, it is found that no laxative effect is produced, and under these circumstances the latter can be secured by following their administration with a solution of citric acid. On account of its antacid property magnesia is also often combined with other cathartics. It has been prescribed in lithiasis and gouty affections, but in these is much less efficient than other alkalies, on account of the small amount of it absorbed. In order to produce alkaline effects upon the blood and urine it should therefore never be given except in cases where the potassium or sodium salts cannot be borne. Magnesium oxide and carbonate form insoluble compounds with mineral acids, oxalic acid, and the salts of arsenic, copper and mercury, while by their alkaline effect on the contents of the stomach they retard the absorption of alkaloids. They may therefore be used as antidotes to all these substances, but as to secure the desired effect they must be given very freely, their bulk at times makes them objectionable. Magnesia is to be preferred, and it is employed in the official arsenical antidote (*see* p. 201). As an antidote to arsenic it is inferior, by itself, to ferric hydroxide, but in the absence of the latter may be resorted to. For this purpose it should be freshly precipitated. Magnesium sulphate is one of the best and most largely employed of saline cathartics. The commonly accepted view is that, like other purgatives of its class, it acts by abstracting water from the intestinal blood-vessels. It is frequently employed for the varieties of constipation associated with hepatic disorder, gout,

ACTION OF MAGNESIUM SALTS.

External.—None.

Internal.—When injected intravenously, magnesium produces much the same effects as potassium, causing paralysis of the heart and central nervous system; but such results are never observed when it is taken by the mouth, as the salts appear to be rapidly excreted by the kidneys. Magnesium oxide and carbonate differ from the other saline cathartics in being very insoluble and in having an alkaline reaction, and in many ways they act like the alkalies, sodium and potassium. In the stomach they are partly converted into magnesium chloride, while in the intestine the carbon dioxide present may dissolve a part by forming the bicarbonate. They have a mild purgative action, and at the same time any excessive acidity in the gastro-intestinal tract is overcome by their **alkalinity.** Magnesium sulphate is a much more **powerful cathartic.** When this salt is converted into the bicarbonate in the small intestine, sodium sulphate is formed, and as the latter is, of course, also cathartic, the effect produced is doubly great. Its action is as a rule very satisfactory, large **watery stools** being produced, with but little nausea or griping, and on account of its non-irritating qualities it will often be retained by the stomach when other remedies of its class are rejected. Like other alkalies, magnesium oxide and carbonate are **diuretic** and have the effect of promoting the alkalinity of the blood and urine, but on account of the difficulty with which they are absorbed, this effect is less pronounced than in the case of sodium and potassium salts. The magnesium of the urine is increased by the administration of magnesium salts, especially if they fail to act on the bowels, but some of the magnesium may perhaps be excreted by the intestine and some even appear in the milk. In the frog these salts are asserted to paralyze the muscles in the same way as potassium, but in mammals this is not the case even when they are intravenously injected, the animal dying from the action on the heart and central nervous system before the muscular action is induced. It is a fact worthy of note that in some instances the formation of large concretions in the bowel, resulting in obstruction, has been

Being non-irritant, magnesium sulphate may be given freely when inflammation is present, and in enteritis and peritonitis it is quite commonly used for its depletant action. It is also claimed that it is better than ipecacuanha in the treatment of tropical and other dysenteries, and for this purpose is recommended to be administered in 4 c.c. (1 fl. dr.) doses of a saturated solution with .60 to 1 c.c. (10 to 15 ♏) of aromatic sulphuric acid every two hours. It is especially adapted to the acute stage, and morphine sulphate may be combined with it, or starch enemata with laudanum employed in addition. In lead-poisoning it is also of great service, especially if associated with sulphuric acid. Thus combined with sulphuric acid it sometimes is efficacious in arresting bleeding from piles, especially if the state of the hæmorrhoidal vessels be due to constipation, and it may also serve to relieve uterine hæmorrhage caused by the presence of a fibroid, or by subinvolution, and congestion of the pelvic viscera. In impaction of the cæcum, with resulting typhlitis, it will often liquefy the fæcal masses and deplete the vessels, and thus remove the obstruction without causing any irritation. Among other conditions calling for the use of an active saline cathartic such as magnesium sulphate may be mentioned cholæmia, uræmia, œdema of the brain, and increased intra-cranial blood-pressure from whatever cause. The citrate is a cooling purgative, which operates mildly. It is very widely employed on account of its acceptability to the stomach and the facility with which it may be taken, and is often especially useful in the case of children.

CALCIUM.

1. **CRETA PRÆPARATA.** — Prepared Chalk. (Drop Chalk.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Hydrargyrum Cum Creta.**—Mercury with Chalk. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Mistura Cretæ.**—Chalk Mixture. **Dose, 16 c.c. (4 fl. dr.).**
3. **Pulvis Cretæ Compositus.**—Compound Chalk Powder. **Dose, 2 gm. (30 gr.).**

2. **CALCII CARBONAS PRÆCIPITATUS.**—Precipitated Calcium Carbonate. **Dose, 1 gm. (15 gr.).**

ACTION OF PREPARED CHALK AND CALCIUM CARBONATE.

External.—Mildly astringent and desiccant.

Internal.—Calcium carbonate is an **antacid**, absorbent and **astringent**, though its action in the latter capacity has not yet been explained. The great proportion of it taken leaves the body in the stools entirely unabsorbed. Such absorption as occurs has been found to take place in the upper part of the intestine, but the bulk of that which is absorbed appears to be re-excreted into the intestine. There is no evidence that it has any diuretic action. The animal carbonates are said to be less liable to derange the stomach than the mineral preparations of calcium.

THERAPEUTICS OF PREPARED CHALK AND CALCIUM CARBONATE.

External.—Prepared chalk is a good dusting-powder in moist eczema, intertrigo and hyperidrosis, and is sometimes used as a protective dressing for ulcers and sores. It is largely employed, sometimes alone and sometimes with other substances, as a dentifrice, because of its mechanical action and also on account of its antacid, astringent and sedative effect upon the gums and buccal mucous membrane. The following are good formulæ for tooth-powders: Potassium chlorate, 4; powdered soap, 8; phenol, 2; oil of cinnamon, 1; precipitated calcium carbonate to 48 parts, or, prepared chalk, 15; powdered blue flag flowers, 15; powdered cuttle-fish bone, 8 parts; oil of lemon, 1 part.

Internal.—Chalk mixture is a useful remedy in diarrhœa, especially when the intestinal discharges are acid, and opiates and astringents are frequently added to it. It should generally be preceded by an evacuant to remove undigested food or other irritating substances. It is principally employed in the case of children. Compound chalk powder and mercury with chalk are also used in the treatment of diarrhœa. Calcium carbonate is given as a restorative and antacid in acid indigestion. Natural mineral waters which contain salts of calcium as prominent constituents, such as those of Contrexéville, Wildungen, Vittel, Clarendon and Waukesha, have gained considerable reputation for the treatment of uric acid gravel and other affections of the urinary system; but it seems probable that the benefit derived from them is principally due to the large amount of liquid swallowed. They are used in quantities of from 1500 to 3000 c.c. (3 to 6 pints) a day, and should be taken between meals in order to avoid indigestion from the excessive amount of fluid.

3. CALX.—Lime. Calcium Oxide. (Burned Lime.)

Preparations.

1. Linimentum Calcis.—Lime Liniment. (Liniment of Calcium Oxide. Carron Oil.)

2. Liquor Calcis.—Lime Water. Solution of Calcium Hydroxide. **Dose, 16 c.c. (4 fl. dr.).**

3. Syrupus Calcis.—Syrup of Lime. Syrup of Calcium Hydroxide. (Syrup of Lime.) **Dose, 2 c.c. (30 ♏).**

ACTION OF LIME.

External.—Lime water, which is mildly astringent, is also slightly caustic, as is the syrup likewise. Slaked lime is a **corrosive** and **disinfectant.** The unslaked lime is changed at once to the hydroxide in the presence of water, but the hydroxide differs from those of the caustic alkalies in being much less soluble. Hence it does not penetrate so deeply or spread so widely.

Internal.—Lime is **antacid** and **astringent.** The reason for its astringent action is unknown, but it has been suggested that it is probably due to its forming an insoluble compound with the surface proteids, in the same way as tannic acid, or to its being deposited as the carbonate or phosphate, and thus protecting the epithelium from irritation. It has the effect of allaying vomiting and it causes a subdivision of the coagula formed by milk in the stomach. It acts as an antidote to zinc chloride, oxalic acid, and mineral acids. The salts of lime are present in very large amount in the normal tissues, and it has been demonstrated that lime is required by the higher organisms, both animals and plants, for some of their functions.

THERAPEUTICS OF LIME.

External.—As a caustic it is seldom employed alone, but is generally combined with caustic potash (forming Vienna paste) or with caustic soda to form what is known as London paste. Lime water is used as a wash for foul and gangrenous ulcers and, either alone or combined with glycerin, in the treatment of acute vesicular eczema. It affords marked relief in the pruritus which sometimes becomes intolerable in eczema and other inflammatory affections of the skin and the itching experienced by the aged. It is also useful as an injection for thread-worms, leucorrhœa, gleet, and ulcerations of the bladder, and Linimentum Calcis is a standard remedy for burns. As the false membranes of diphtheria, croup, plastic bronchitis, etc., are composed largely of mucus, they may be broken down by alkalies, and for this purpose lime water is quite commonly employed. A lime water spray, produced by the atomizer, may be inhaled by the patient, or the patient may inhale the vapors arising from lime undergoing the process of slaking with water.

Internal.—Lime water is very largely used in the treatment of vomiting, and for this purpose is generally given with milk, in varying proportion. It is constantly added to the milk of infants and invalids, as it prevents the formation of bulky coagula, and milk thus treated is more easily digested and less liable to cause intestinal disturbance. In cases of acid poisoning the syrup should be employed, or lime shaken up with water (milk of lime), as lime water contains too little of the base to be of service. Lime is especially valuable in the treatment of oxalic acid poisoning. As an antacid in the stomach it is inferior to many other alkalies, since it tends to delay the evacuation of the contents. Lime water and the syrup are both used as astringents in diarrhœa, more particularly in children, and when the stomach is irritable. In dyspepsia accompanied with vomiting of food a diet exclusively composed of lime water and milk is often more effectual than any other plan of treatment. Lime water has sometimes been used in the treatment of rickets and bone-softening, but when the fact is considered that this contains really less lime than cow's milk, it is difficult to see how it can be of any service in such conditions. Indeed, the utility of giving lime salts at all in rickets has been disputed, as it is contended that the disease is not due to a lack of lime in the food nor in the tissues generally, but to some abnormal condition which prevents the lime salts from being deposited in the bones, although they may be present in abundance in the blood. It has been claimed that some improvement has occasionally been observed in cases in which the blood seemed less capable of coagulating them normally—particularly hæmophilia and aneurism—as a result of the use of lime, but it has again been contended that the deficient coagulability is scarcely likely to be due to lack of the lime salts, since much more is taken in the food than is sufficient for the organism, and the medicinal lime preparations are not more easily absorbed than the combinations present in food. The urine of persons who take large quantities of lime water is stated to be often alkaline, and sometimes ammoniacal. The latter circumstance has been explained as due to the presence of calcium carbamate, which readily undergoes ammoniacal disintegration.

4. **CALCII PHOSPHAS PRÆCIPITATUS.**—Precipitated Calcium Phosphate. **Dose, 1 gm. (15 gr.).**

Preparation.

Syrupus Calcii Lactophosphatis.—Syrup of Calcium Lactophosphate. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF CALCIUM PHOSPHATE.

So far as regards its mass, calcium phosphate is, next to water, the most important of the inorganic constituents of the body, and in all the solid tissues it is of service by giving to them their proper consistence and solidity. Thus, in the enamel of the teeth, the hardest tissue of the body, its quantity is no less than 885 parts in 1000, while in the bones there are 576 to the 1000. The large amount of it required by the system is supplied by the food (meats, vegetables, eggs, milk, bread and cereals all containing it), and a deficiency of the salt in the food leads to softening of the bones. The great proportion of the lime taken either in the food or as a remedy is found to leave the body in the fæces entirely unabsorbed, while a small quantity of it, whether it is taken in a soluble or insoluble form, is absorbed from the alimentary canal. This portion circulates in the blood (in combination with proteids, it is thought), and is slowly excreted, unless there is a deficiency in the supply of lime, when it may be utilized by the tissues. When larger quantities are injected intravenously or subcutaneously, it is stated that the calcium of the blood remains abnormally high for some time, but that all the lime thus injected is not in the circulation throughout its stay in the body; some of it being temporarily deposited in some unknown organ, from whence it is gradually withdrawn and excreted after the first excess is eliminated. The lime is excreted in part in the urine, but for the most part through the epithelium of the large intestine.

Therapeutics of Calcium Phosphate.

Notwithstanding the theoretical objections which have been urged against the utility of lime salts in rickets, calcium phosphate has been largely employed in the treatment of this disease, and with alleged good results. When used in rickets it is important that it should be made from bones. By some pediatrists the syrup of calcium lactophosphate is given the preference, and this preparation is also used to a large extent in tuberculosis and other debilitated conditions of the system. Pregnant and nursing women are treated with calcium phosphate for the purpose of supplying lime salts for the bones of the child. It is frequently combined with other phosphates, such as those of iron, sodium and potassium, in the treatment of rickets, mollities ossium, the different forms of scrofula, and anæmic conditions generally. It has also been thought useful in facilitating the union of fractured bones, and in experiments upon dogs and rabbits it is asserted that in fractures the callus forms more quickly under its use than without it. Being inert and almost insoluble, it is sometimes employed as a constituent of pills containing essential oils, and as it prevents agglutination, is also used as a diluent for powders.

5. CALCII CHLORIDUM.—Calcium Chloride. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Action of Calcium Chloride.

Calcium chloride is an irritant and resolvent. It is extremely deliquescent, and its power of absorbing water is utilized for the dehydration of alcohol and ether and for other purposes. Outside the body it hastens the coagulation of the blood and produces a firmer clot.

Therapeutics of Calcium Chloride.

On account of its solubility in water calcium chloride is readily administered, and it has been employed in the treatment of chronic bronchitis, pneumonia, and phthisis and has been recommended for gastric catarrh and fermentative dyspepsia. Its most important use is for the hæmorrhages of scurvy and hæmophilia; one large daily dose of 2 gm. (30 gr.) is preferable to smaller ones frequently repeated. If maximum doses are administered for several days previously, it is often possible to perform operations upon bleeders. It may be of use in hæmatemesis and hæmoptysis, and, possibly, also for aneurism. It is said to sometimes cause the resolution of glandular swellings and the calcification of the cicatrization of tuberculous deposits, and also to be of service in lupus and other skin diseases.

B. Drugs Acting on the Red Corpuscles.

IRON.

1. **FERRUM.**—Iron.

2. **FERRUM REDUCTUM.**—Reduced Iron. (Quevenne's Iron. Iron by Hydrogen.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

3. **FERRI SULPHAS.**—Ferrous Sulphate. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

Preparations.

1. **Ferri Sulphas Exsiccatus.**—Exsiccated Ferrous Sulphate. **Dose, 0.125 gr. = 125 milligm. (2 gr.).**

2. **Ferri Sulphas Granulatus.**—Granulated Ferrous Sulphate. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

3. **Mistura Ferri Composita.** — Compound Iron Mixture. **Dose, 16 c.c. (4 fl. dr.).**

4. **Pilulæ Ferri Carbonatis.**—Pills of Ferrous Carbonate. (Ferruginous Pills. Chalybeate Pills. Blaud's Pills.) **Dose, 2 pills.**

4. **FERRI CARBONAS SACCHARATUS.**—Saccharated Ferrous Carbonate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

5. **MASSA FERRI CARBONATIS.**—Mass of Ferrous Carbonate. (Vallet's Mass.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

6. **SYRUPUS FERRI IODIDI.**—Syrup of Ferrous Iodide. **Dose, 1 c.c. (15 ♏).**

7. **PILULÆ FERRI IODIDI.**—Pills of Ferrous Iodide. **Dose, 2 pills.**

8. **FERRI CHLORIDUM.**—Ferric Chloride. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

9. **LIQUOR FERRI CHLORIDI.**—Solution of Ferric Chloride. **Dose, 0.1 c.c. (1½ ♏).**

Preparations.

1. **Liquor Ferri et Ammonii Acetatis.**—Solution of Iron and Ammonium Acetate. (Basham's Mixture.) **Dose, 16 c.c. (4 fl. dr.).**

2. **Tinctura Ferri Chloridi.**—Tincture of Ferric Chloride. **Dose, 0.5 c.c. (8 ♏).**

10. **LIQUOR FERRI TERSULPHATIS.**—Solution of Ferric Sulphate.

11. **LIQUOR FERRI SUBSULPHATIS.**—Solution of Ferric Subsulphate. **Dose, 0.2 c.c. (3 ♏).**

12. **FERRI HYDROXIDUM** (Ferri Oxidum Hydratum, U. S. P., 1890).—Ferric Hydroxide. (Hydrated Ferric Oxide.)

13. **FERRI HYDROXIDUM CUM MAGNESII OXIDO.**—Ferric Hydroxide with Magnesium Oxide. **Dose** (arsenical antidote), **120 c.c. (4 fl. oz.).**

14. **FERRI ET AMMONII SULPHAS.**—Ferric Ammonium Sulphate. (Ammonio-Ferric Alum.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

15. **FERRI PHOSPHAS SOLUBILIS.**—Soluble Ferric Phosphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Elixir Ferri, Quininæ et Strychninæ Phosphatum.**—Elixir of the Phosphates of Iron, Quinine and Strychnine. **Dose, 4 c.c. (1 fl. dr.).**

2. **Glyceritum Ferri, Quininæ et Strychninæ Phosphatum.**—Glycerite of the Phosphates of Iron, Quinine and Strychnine. **Dose, 1 c.c. (15 ♏).**

3. **Syrupus Ferri, Quininæ et Strychninæ Phosphatum.**—Syrup of the Phosphates of Iron, Quinine and Strychnine. (Easton's Syrup. Syrupus Trium Phosphatum.) **Dose, 4 c.c. (1 fl. dr.).**

16. **FERRI ET AMMONII TARTRAS.**—Iron and Ammonium Tartrate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

17. **FERRI ET POTASSII TARTRAS.**—Iron and Potassium Tartrate. (Tartrated Iron.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

18. **FERRI CITRAS.**—Ferric Citrate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

19. **FERRI ET AMMONII CITRAS.**—Iron and Ammonium Citrate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Vinum Ferri.—Wine of Iron. (Wine of Ferric Citrate.) **Dose, 8 c.c. (2 fl. dr.).**

20. **FERRI ET QUININÆ CITRAS.**—Iron and Quinine Citrate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Vinum Ferri Amarum.—Bitter Wine of Iron. **Dose, 8 c.c. (2 fl. dr.).**

21. **FERRI ET QUININÆ CITRAS SOLUBILIS.**—Soluble Iron and Quinine Citrate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

22. **FERRI ET STRYCHNINÆ CITRAS.**—Iron and Strychnine Citrate. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

23. **FERRI PYROPHOSPHAS SOLUBILIS.**—Soluble Ferric Pyrophosphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

24. **FERRI HYPOPHOSPHIS.** — Ferric Hypophosphite. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

Preparation.

Syrupus Hypophosphitum Compositus.—Compound Syrup of Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

Unofficial Preparations.

Ferri Arsenas.—Iron Arsenate. **Dose, 0.003 to 0.03 gm.; $\frac{1}{20}$ to ½ gr.**

Ovoferrinum.—Ovoferrin. (Iron Vitellin.) **Dose, 8 to 15 c.c.; 2 to 4 fl. dr.**

ACTION OF IRON AND ITS SALTS.

External.—While the salts of iron and their solutions have no action on the unbroken skin, on the abraded cuticle and on mucous membrane they have a powerful **astringent** effect by reason of their property of precipitating proteids; so that all **albuminous fluids** are **coagulated** by them. In consequence of this action on the blood, as well as their effect on the vessels themselves, by which the calibre of the latter is diminished by the contraction of the coagulated albumin, they tend to arrest hæmorrhage, and constitute in fact the most efficient **local hæmostatics** at our command. While, however, some of the iron salts, such as the chloride, the nitrate, and the sulphate, have very marked astringent value, others are practically inert in this respect. Solutions of both ferrous and ferric salts have more or less **antiseptic, germicidal** and **disinfectant** activity, and since, in addition to arresting putrefaction, they neutralize the sulphur and ammonium compounds given off from decaying matter, they are also **deodorizers.** Ferric oxides, furthermore, have the power of converting oxygen into ozone.

Internal. *Mouth.*—Most of the preparations of iron have a peculiar metallic and astringent taste, known as chalybeate, which is most pronounced in the case of the persalts. The insoluble and albuminous ones should be practically tasteless. The **blackening of the teeth and tongue** which is liable to result from the use of iron preparations has been supposed to be due to the formation of iron tannate from the tannic acid of the food or from the sulphur present in carious teeth or in the tartar. To avoid this it is advisable to take them through a glass tube and immediately afterwards to brush the teeth. The free acid in the tincture of ferric chloride or the acidity of the chloride itself will destroy the dental enamel even if diluted with eight parts of water.

Gastro-intestinal Tract.—In the stomach almost all the iron salts, it is supposed, form chlorides to a greater or less extent, and are then changed into albuminates. Ferric chloride is said to be the only one of them which does not abstract hydrochloric acid from the gastric juice, and it is believed that it is probably to this circumstance that its peculiar value as a chalybeate remedy is due. Inorganic salts, if taken in sufficient quantity, act as gastro-intestinal irritants, causing pain and discomfort, with nausea and vomiting, and sometimes purging. The more strongly acid ones have a more or less marked **caustic** effect upon the stomach, in consequence of the acid liberated after the formation of chlorides, and this is the case even with preparations of ferric chloride, which always contain free acid. Hence those preparations which are not at all or but slightly acid, such as reduced iron, ferrous carbonate, and the unofficial iron vitellin, do not as a rule cause digestive trouble, though it can also be said that they are generally not so efficient as the stronger preparations. However, this free acid may be neutralized by the addition of sodium bicarbonate, so that the tincture of ferric chloride will be acid only so far as the basic ferric chloride has an acid reaction; nor does this neutralization impair its therapeutic properties, for hydrochloric acid is added to it in the stomach. An effective preparation is now made, in which these disadvantages of the tincture of ferric chloride are removed, which is known as Weld's syrup of ferric chloride. As ferric chloride is strongly astringent, most iron salts have an astringent action on the stomach, the degree of astringency depending upon the amount of the chloride which is formed from the gastric juice or is otherwise present. In the duodenum it is believed that the iron compounds, having been changed from chlorides into albuminates in the stomach, may in part be absorbed in solution, or precipitated and taken up as solids by the epithelial cells and the leucocytes, while the great bulk is carried on into the lower parts of the intestine. Under medicinal doses the secretions of the alimentary canal show a tendency to diminish, with the production of constipation, with hard, dry stools, while the **fæces** are **blackened** from the formation of ferrous sulphide and tannate.

Absorption and Excretion.—The absorption of iron has been the subject of much discussion, but it seems to be now well established that inorganic iron salts, as well as the organic, are absorbed by the intestine. While authorities differ as to whether organic iron given by the mouth increases the amount of iron in the urine or not, the preponderance of evidence is to the effect that the quantity which is normally excreted in the urine (0.5 to 1.5 mg.) is not affected by the internal administration of either the organic or inorganic preparations. Hence the fact that an iron salt given by the mouth does not increase the urinary iron affords no ground for the assumption that it has not been absorbed. Neither does the iron absorbed increase the amount of iron in the bile or other excretions. The latest results of experimental researches would seem to indicate that the small part of the iron which in the duodenum is absorbed by the epithelium and leucocytes passes through the lymph channels to the mesenteric glands, and thence through the thoracic duct to the blood-vessels. It is then deposited in the spleen, where it may undergo some changes in form; later it is taken up by the blood and deposited in the liver and perhaps in the bone marrow. Where the supply of iron has been inadequate for the formation of hæmoglobin, it is thought that the originally inorganic iron is probably worked into higher forms, and eventually into hæmoglobin in the liver. When there is no such deficiency, however, the liver slowly yields its store of iron to the blood, which carries it to the cæcum and large intestine, by the epithelium of which it is finally excreted. Iron is normally present in all the tissues and secretions, but the greater portion of the total quantity in the body (estimated to be about 2.5 to 3.5 gm.; 40 to 55 gr., in a healthy adult), is to be found in the blood as hæmoglobin. While some .0054 to .0108 gm. ($\frac{1}{12}$ to $\frac{1}{6}$ gr.) of iron is taken in the food *per diem,* about the same amount is excreted, chiefly in the fæces and to a much smaller extent in the urine. Any excess of elimination following subcutaneous injection or excessive absorption from the intestine, it may be noted, takes place through the intestinal mucous membrane.

Blood.—It is very much open to question whether an increase in the number of red blood-corpuscles, or any other especial effect on the blood, is caused by the administration of iron in health. In many cases of anæmia, however, and particularly of chlorosis, the remedy has the effect of rapidly increasing both the number of these corpuscles and the amount of hæmoglobin in the blood. Iron is therefore said to be a **hæmatinic,** and as an improvement in the quality of the blood results in an improvement in the functions of the various organs of the body, it is also regarded as a **tonic.** Although the latest investigations show that inorganic iron follows the same course in the tissues as food iron, in the treatment of anæmic conditions it may sometimes have a much more satisfactory effect than the latter. Thus, it has been pointed out that food-iron is always accompanied by a large amount of colloid material, which may materially delay its absorption, in particular as it seems absorbable in only a very small part of the alimentary tract, the duodenum; inorganic iron on the other hand is much less completely enveloped and may be more easily absorbed. Moreover, the iron preparations are used in much larger amounts than the food-irons, since to obtain the same effect from the latter it would be necessary to give more of them than could be digested. Accordingly, certain cases of chlorosis are met with in which little or no improvement seems to result from the use of foods containing iron, but which recover rapidly under inorganic iron.

General Symptoms.—The general effects of iron upon the system, it has been found, can be obtained only by the intravenous injection of double salts, like sodio-ferric tartrate, which do not coagulate the blood and at the same time are capable of freeing the iron ion in the tissues. From the results of experimentation it would appear that iron, like the other heavy metals, has a specific **irritant** effect on the gastro-intestinal mucous membrane, and to a less extent on the kidney. It also **depresses** and eventually **paralyzes** the **central nervous system,** though how far this is the result of direct action and how far it is secondary to its effects in the alimentary canal is as yet unknown. The heart is apparently but little affected, though towards the end a rapid fall of blood-pressure is noticed. Post-mortem there is found swelling and congestion of the mucous membrane of the stomach and intestine, with numerous small blood extravasations in many instances.

Remote Effects.—In addition to the improvement of the general system in anæmic subjects derived from the continued administration of iron, it has been thought that this agent has a direct effect on the kidneys (as a mild diuretic), as well as upon the menstrual function. More oxygen is carried to all the tissues, however, and it is possible that these supposed specific effects, which are not of a marked character, are simply the result of the benefit from the remedy in which the whole body shares. That the iron salts should have any remote astringent or hæmostatic action, as has been contended by some, has never been demonstrated, and on theoretical grounds would seem to be highly improbable. Indeed, it is held by high authorities that to give iron in cases of metrorrhagia or menorrhagia is only to increase the loss of blood. The continued use of ferruginous preparations is liable to interfere with the digestion, and may produce gastric oppression, and even nausea and vomiting. In addition, they may give rise to acne, and in rare instances to symptoms of plethora and vascular excitement, with possibly hæmorrhages from the mucous membranes. Exceptionally also they may induce irritation of the kidneys, while in gouty subjects iron is apt to be badly borne. In general, the ferrous salts are likely to produce less disturbance in the system than the ferric ones, and the preparations which are best tolerated are reduced iron, the phosphate, and the pyrophosphate.

THERAPEUTICS OF IRON AND ITS SALTS.

External.—Liquor Ferri Subsulphatis (Monsel's solution) and solutions of the sulphate and chloride have long been held in the righest repute as local hæmostatics, and are usually employed on lint or cotton, the special method of application depending on the part where the hæmorrhage occurs. These preparations, however, form very disagreeable clots, which readily decompose and give rise to septic infection. The astringent salts of iron are not to be recommended in either superficial or deep wounds, where the hæmorrhage can usually be controlled with more satisfactory results by properly applied pressure. As an astringent for painting on the parts in pharyngitis or tonsillitis Liquor Ferri Chloridi, diluted with an equal quantity of water, is of service, or a solution of 1 part of ferric chloride in 4 of glycerin may be used. The aqueous solution of the chloride has also been employed as a spray for hæmoptysis, but is objectionable for this purpose, as it is very liable to excite coughing. The tincture of ferric chloride has been highly recommended as a local application to the throat in diphtheria, and in erysipelas is sometimes painted over the inflamed surface. A wash containing .12 to .3 gm. (2 to 5 gr.) of the sulphate to 30 c.c. (1 fl. oz.) of water is often useful in chronic and indolent ulcers, and a solution of the sulphate (1 to 480) has also been used in gleet.

Internal. *Gastro-intestinal Tract.*—In hæmorrhage of the stomach, from whatever cause, the astringent preparations may often be employed with advantage. If the bleeding is profuse, 4 c.c. (1 fl. dr.) of Liquor Ferri Chloridi, with 4 c.c. (1 fl. dr.) of glycerin to facilitate swallowing, should be given every hour or oftener; but such large quantities are not required in milder cases. Intestinal hæmorrhage may also be treated in the same way, though the success of the remedy will depend largely on the location of the trouble.

It is a common practice to counteract the tendency of the salts of iron to cause constipation by combining purgatives with them, but this method interferes with the time during which iron remains in the intestines, and it is better to administer the laxative separately, so that the dose can be regulated according to circumstances. A pill of ferrous sulphate and extract of nux vomica is often found very effectual in the treatment of chronic constipation. Here the active agent would seem to be the nux vomica, although it has been claimed by some that such constipation may be overcome by large doses of ferrous sulphate alone. At least, the constipating effect of iron salts is no doubt often much exaggerated. They have sometimes been given for diarrhœa, but this can be more satisfactorily treated by many other drugs.

Thread-worms may be killed by a rectal injection of 4 c.c. (1 fl. dr.) of the tincture of ferric chloride in 250 c.c. (half a pint) of water, with the patient in the knee-chest position.

One of the most efficient means of treating arsenical poisoning is by ferric hydroxide with magnesium oxide. To prepare this for use a mixture of magnesium oxide (10 gm.) with sufficient water to make a homogeneous, thin magma is added gradually to solution of ferric sulphate, 40 c.c., mixed with 125 c.c. of water, and the product is then shaken until a uniform, smooth mixture results. For the rapid preparation of this antidote it is advised that the diluted solution of ferric sulphate and the mixture of magnesium oxide with water should always be kept in readiness, in separate bottles. It should be given in large doses and frequently repeated. Another arsenical antidote is prepared by mixing together 90 c.c. (3 fl. oz.) of solution of ferrous sulphate and 30 gm. (1 oz.) of sodium carbonate diluted with water, and of this, 15 c.c. (½ fl. oz.) should be given at short intervals. The insoluble arsenite which is formed in the body may be gotten rid of by a large dose of some simple purgative, such as magnesium sulphate. Poisoning by arsenic may be also successfully treated by a dose of common salt or of sodium bicarbonate, followed by 30 c.c. (1 fl. oz.) of dialyzed iron (which is useless as a medicinal iron preparation), diluted with water.

Ferruginous preparations are often administered with advantage for the purpose of improving the appetite and digestion, and it is held by some that the chief use of iron as a remedy, even in anæmia, is to promote the digestive function. To aid appetite and digestion ferrous sulphate will usually be found the most serviceable preparation.

Blood.—As has been stated, the administration of iron in anæmia, and especially chlorosis, often rapidly increases the amount of hæmoglobin and the number of red corpuscles; and it is to restore these to their normal quantity that the ferruginous preparations are most commonly given. It is to be noted, however, that they are useless in pernicious anæmia and of little value, if any, in the anæmia of leukæmia, exophthalmic goitre, and Hodgkin's disease. In common forms of anæmia which are secondary to some special cause, such as hæmorrhage, lead poisoning, malaria, scurvy, etc., the removal of the cause is essential to recovery, but the use of iron salts is often of great service in aiding the latter. It has frequently been observed that iron has very little, if any, beneficial effect upon anæmic patients when it does not increase the desire for food and the ability to digest it, and in the anæmic condition, therefore, ferruginous preparations should be given not only for the purpose of restoring the quantity of the elements in which the blood is deficient, but also to increase the energy of the primary assimilation. To secure the latter object increasing quantities of the more active astringent salts, especially the sulphate and the chloride, are best. Large doses of these are frequently well borne, though it is worth noting that considerable amounts of the sulphate have been known to occasion obstruction of the bowels. When they produce any untoward effects they should be replaced by other preparations, preference being given to the most astringent ones which will be tolerated by the stomach. The styptic taste of the astringent compounds may be concealed by administering them with 4 c.c. (1 fl. dr.) of glycerin, which also has the effect of reducing some of the ferric to a ferrous salt, and this substance is frequently added to the tincture of ferric chloride. To restore the amount of hæmoglobin and the number of red corpuscles, small doses—.06 to .12 gm. (1 to 2 gr.)—of reduced iron or of the carbonate, or some one of the combinations with vegetable acids, are usually the most serviceable. As the scale preparations rarely disagree, they are much used for patients with weak digestion, and small doses can generally be continued for an indefinite period. Red wines and the natural chalybeate waters, such as those of La Bourboule, Levico, Flitwick and the Columbian spring, Saratoga, may also prove useful. The numerous other symptoms besides dyspepsia which are dependent upon anæmic conditions, such as constipation, neuralgia, amenorrhœa, etc., are naturally improved by the treatment of the anæmia with iron. In chlorosis better results are often obtained from combinations of iron with strychnine or arsenic than from iron alone. Easton's syrup (Syrupus Ferri, Quininæ et Strychninæ Phosphatum) and Easton's pill (Pilula Trium Phosphatum), which consists of quinine, .06 gm. (1 gr.); strychnine, .002 gm. ($\frac{1}{32}$ gr.); concentrated phosphoric acid, .10 c.c. (1½ ♏); and licorice powder to .30 gm. (5 gr.) are much employed in convalescence after serious illness and in anæmia and chlorosis generally. Iron arsenate, although not official, is an excellent remedy in chlorosis. Good results have sometimes been claimed from ferrous iodide in cases of rheumatoid arthritis, and this preparation is very largely used for rachitic and scrofulous children, especially in association with cod liver oil. The tincture of ferric chloride, in doses of .60 to 1.20 c.c. (10 to 20 ♏), sometimes as often as every hour, has proved beneficial in diphtheria and other severe diseases affecting the throat, and this is a favorite remedy in erysipelas. As the administration of iron tends to elevate the temperature in the sick, however, ferruginous preparations are generally inadvisable in other febrile diseases. Some individuals cannot take iron at all, on account of the severe headache or indigestion which it induces. Iron should always be administered when the stomach is full (after meals), except when given for follicular tonsilitis, diphtheria, erysipelas, gastric hæmorrhage, or arsenical poisoning.

Kidneys.—It would seem that iron probably has some specific action on the kidney, though its diuretic effect is comparatively slight. In Bright's disease the tincture of ferric chloride is constantly resorted to, both for its tonic and diuretic properties. Liquor Ferri et Ammonii Acetatis (Basham's mixture), an elegant preparation which is useful as a diaphoretic as well as a diuretic, has long been a favorite prescription in the anæmia of both acute and chronic parenchymatous nephritis.

The Different Preparations of Iron.—While many of these are quite strongly astringent, others are practically non-astringent. There are some, viz., the iodide, the arsenate, the phosphate, iron and quinine citrate, and iron and strychnine citrate, in which the drugs with which the iron is combined increase their value and give them special applications. While it has been thought that the arsenate must be exhibited in such small doses, in order to avoid arsenical poisoning, that the iron in it can have little or no effect, clinicians have found that practically this preparation is by no means so actively toxic as is generally supposed, and that in comparatively large doses it is an excellent remedy, particularly in chlorosis. In any case where arsenic is indicated in which such doses are not well borne, it is better to administer the two drugs separately. Ferric phosphate, which always contains some free phosphoric acid, is a reliable hæmatinic, and it is a very palatable preparation. It has been largely used for children, and especially in rickets, under the idea that the phosphorus in it would promote the growth of bones. Parish's food, known also as Squire's chemical food, and Dusart's syrup both have for their chief ingredient ferric phosphate; the dose of each is 2 to 8 c.c.; ½ to 2 fl. dr. While in ferrous iodide the proportion of iron to iodine is small (1 to 9), it is a very useful preparation, although it is especially liable to injure the teeth. The iron and quinine citrate is a favorite mild preparation for slight cases of anæmia, but must not be prescribed with alkalies, as they precipitate the quinine. Doubtless the most satisfactory unofficial iron preparation is iron vitellin, which is not irritant, is readily assimilated, and is a prompt and efficient hæmatinic.

ARSENIC.

1. **ARSENI TRIOXIDUM.**—Arsenic Trioxide. (Arsenous Acid. White Arsenic.) **Dose, 0.002 gm. = 2 milligm.** ($\frac{1}{30}$ **gr.**).

Preparations.

1. **Liquor Acidi Arsenosi.**—Solution of Arsenous Acid. **Dose, 0.2 c.c. (3 ♏).**

2. **Liquor Potassii Arsenitis.**—Solution of Potassium Arsenite. (Fowler's Solution.) **Dose, 0.2 c.c. (3 ♏).**

2. **SODII ARSENAS.**—Sodium Arsenate. **Dose, 0.005 gm. = 5 milligm.** ($\frac{1}{10}$ **gr.**).

3. **SODII ARSENAS EXSICCATUS.**—Exsiccated Sodium Arsenate. **Dose, 0.003 gm. = 3 milligm.** ($\frac{1}{20}$ **gr.**).

Preparation.

Liquor Sodii Arsenatis.—Solution of Sodium Arsenate. (Pearson's Solution is really one-fifth as strong as the official.) **Dose, 0.2 c.c. (3 ♏).**

4. **ARSENI IODIDUM.**—Arsenous Iodide. **Dose, 0.005 gm. = 5 milligm.** ($\frac{1}{10}$ **gr.**).

Preparation.

Liquor Arseni et Hydrargyri Iodidi.—Solution of Arsenous and Mercuric Iodides. (Donovan's Solution.) **Dose, 0.1 c.c. (1½ ♏).**

Unofficial Preparations.

Acidum Cacodylicum.—Cacodylic Acid. **Dose, .24 gm.; 4 gr.**

Sodii Cacodylas.—Sodium Cacodylate. **Dose, .05 to .15 gm.; ¾ to 2½ gr.,** hypodermatically.

Ferri Arsenas.—Iron Arsenate. **Dose, 0.005 gm. to 0.008 gm.; 1/12 to ⅛ gr.**

ACTION OF ARSENICAL COMPOUNDS.

External.—Arsenic trioxide has no effect on the unbroken skin, unless it is repeatedly applied or allowed to remain in contact with it for some time, when it may occasion redness or eruptions of various kinds. Upon denuded surfaces and mucous membrane it has a considerable though slow caustic action. It acts much more energetically upon the higher than upon the lower organisms, and is not therefore of value as a germicide. While arsenic is toxic to all animals having a central nervous system and to most of the higher plants, it is not so to all lower organisms, and hence cannot be regarded as a general protoplasmic poison. It has the property of preserving animal tissues almost indefinitely. When metallic arsenic in a state of fine division is rubbed into the skin some toxic symptoms are observed which are thought to be due to its absorption in the form of an oxide.

Internal. *Alimentary Canal.*—Toxic doses of arsenical preparations produce an acute **gastro-enteritis.** How far this is due to local action is now considered somewhat uncertain. As has been stated, the caustic action occurs but slowly, and the post-mortem findings show that the corrosion is seldom extensive. Moreover, it has been found that the gastro-enteritis may be obtained with equal facility by injecting arsenic into the circulation. From the fact that under these circumstances some arsenic is excreted into the alimentary canal there may no doubt be some local action, but it is held that the quantity thus excreted is quite insufficient to account for the symptoms. Still further, it is known that arsenical compounds do not, like the corrosive poisons, change proteids in solution. The action of arsenic on the alimentary canal cannot therefore be regarded as due to any ordinary form of corrosion. No matter how it is introduced into the system, the **first** and most **marked effects** are observed in the **intestine.** In consequence of the capillary paralysis produced by the drug there results an exudation, which, having caused the throwing off of the epithelium in shreds, is poured out into the gut, where it becomes in great part coagulated. The epithelial coat of the intestine is found to have undergone fatty degeneration, and the degenerated epithelium sometimes closely resembles false membrane. The effect of this action is to set up a diarrhœa with stools having a "rice water" appearance, due to the shreds of mucous membrane and coagulated exudation which characterize them. Attention has been called to the fact that the pathology of this condition is exactly the same as that of Asiatic cholera, so that without a history it is impossible to distinguish between the two except by chemical examination of the dejecta. In exceptional instances the dilatation of the capillaries caused is so extreme that they become ruptured, and there result ecchymoses upon the mucous membrane, or even hæmorrhage into the intestine or stomach, with bloody stools or vomiting. In therapeutic doses arsenic acts as a **gastric stimulant,** the dilatation of the vessels causing an increased flow of gastric juice; and in the same way the secretions of the duodenum are stimulated. It both increases the appetite and promotes digestion, and its specific action on the epithelium is no doubt concerned in the production of this effect.

Blood-vessels and Circulation.—Mention has been made of the paralysis of the capillary vessels produced by arsenic. It is now believed by many that this capillary paralysis explains the whole course of the toxic action of the drug; the phenomena noted resembling those produced by an irritant inflammation, one of the essential features of which is increased permeability of the capillaries. In arsenical poisoning there is an early and pronounced **fall of blood-pressure,** and this has been demonstrated to be almost entirely vascular in origin. The vascular paralysis occasioned is mainly peripheral, and as the arterioles are found to be still capable of contracting, it is assumed that the structures beyond them, namely the capillaries, which moreover, are known to have become more permeable, are the seat of the paralysis. In addition, however, arsenic has some direct action upon the heart, paralyzing its rhythmic power and also depressing its contractility. In the excised heart of the frog the rapidity and force of the heart are diminished till the organ finally stops. Some of the most recent investigators, in accounting for the fall of blood-pressure, explain that the vasomotor centre and later the splanchnic nerves lose their control over the vessels. The dilatation of the mesenteric vessels leads to very marked congestion of the stomach and intestine, and, along with the lessened efficiency of the heart, reduces the pressure to zero. It would seem, therefore, that arsenic is poisonous chiefly from its depressant action on the vessels of the splanchnic area.

Blood.—Opinions differ somewhat as to the action of arsenic on the blood. Some observers have found that in the normal subject it diminishes the number of the red corpuscles, but does not alter the total hæmoglobin of the blood. Others find the blood-cells and hæmoglobin unaltered by arsenic in normal animals, but describe the bone-marrow as evidently in a state of unusual activity, indicated by its increased vascularity, greater number of red corpuscles, and lessened fat-cells. In a case of pernicious anæmia recently examined it was noted that arsenic increased the number of newly formed red corpuscles, but that the number of more mature ones was diminished. While the action of arsenic is still obscure, it may be stated that the amount of hæmoglobin does not seem to be affected by it, and that in certain diseases in which deficiency of the red corpuscles is a prominent symptom its administration is known to be capable of increasing their number, while in chlorosis and in health it apparently does not do so. In conditions of general poor health any improvement in the blood under its use has by many been attributed to improved appetite and increased nutritional activity.

Respiration.—The respiration is temporarily accelerated by the intravenous injection of arsenic. In cases of poisoning in man it is only late that it is seriously affected, but it ceases before the heart. The failure of respiration is thought to be due to exhaustion and low blood-pressure, rather than to any specific action on the respiratory centre.

Nervous System.—In frogs arsenic produces a descending paralysis, and it is recognized that in them the brain, spinal cord, and nerve terminations are directly acted on by it. In mammals, however, there is no evidence of such direct action in acute poisoning, though in chronic poisoning, as well as after a single large but not immediately fatal dose, lesions have sometimes been observed either in the spinal cord or the peripheral nerves.

Absorption and Excretion.—Arsenic is taken into the blood with great facility, and that absorption may take place even from the unbroken skin is shown by the fact that cases of poisoning occur from the use of cosmetic preparations containing the drug. It is excreted in the urine, fæces, sweat, and all the other excretions, though chiefly by the kidney, and the process is a very slow one. It is stored in all the organs; some authorities stating that it is found, after absorption, in largest quantity in the liver, while others deny this. By means of the placental circulation it may also pass from the mother to the fœtus. A minute amount of arsenic is normally present in the thyroid and thymus glands, the brain, and the skin in man, but none is found in the liver. Owing to its more intense action on the alimentary canal, the effect of arsenic on metabolism is not so liable to be noted as in the case of phosphorus, but it is very much the same. While the nitrogen of the urine is considerably increased, it is somewhat uncertain whether this is to be attributed to an increase in the urea or of other nitrogenous substances. The ammonia seems to be increased, while the glycogen of the liver disappears entirely, and the liver is apparently incapable of forming it from the sugar of the food. The fatty degeneration which characterizes its action on the gastric and intestinal epithelium is also found in the liver and kidney, the muscle-cells of the heart, the blood-vessels and striated muscles, and the lining membrane of the alveoli of the lungs. While arsenic, like phosphorus, lessens the oxidation of the tissues and causes fatty degeneration of the cells of various organs, it seems probable that it may also increase the waste of the proteids of the body directly, though the increase in the nitrogen of the urine may possibly be secondary to the other features. The fatty degeneration which occurs may have the same results as in phosphorus poisoning. The liver is found to be somewhat enlarged, while the pressure on the bile ducts prevents the escape of bile into the intestine. Jaundice, however, is but rarely a very marked feature of arsenical poisoning, and may be entirely absent. The improvement in nutrition under arsenic in doses insufficient to induce chronic poisoning is not well understood, though it may be that more of the food is utilized by the digestive apparatus, while at the same time less proteid is decomposed by the tissues. While it cannot be regarded at present that the effects of arsenic on the nutrition are definitely established, it is a recognized fact that as long as the drug does not interfere with digestion and absorption, it increases the excretion of nitrogen. Under these circumstances it also causes increased deposition of fat. In the mountainous districts of Styria many of the inhabitants regularly eat white arsenic with the result of an increase in appetite, weight and strength and an improvement in the complexion. They gradually accustom themselves to use quantities which would prove fatal to ordinary individuals, and this tolerance seems the more remarkable as it has never been found possible to secure such an acquired immunity in the case of animals. It has been suggested that an antitoxin may be developed in these people. Usually, it is said, large doses are taken by them once or twice a week, and no fluid is swallowed for some time afterwards, so that some of the poison may pass through the bowel unabsorbed. These Styrian peasants generally live to old age, and no toxic symptoms are observed in them. On the other hand, the miners of Reichenstein, who are constantly exposed to arsenic, as it is contained in large quantities in the ore, are shortlived. They are described as very subject in childhood to severe rickets and in adult life to dropsies and respiratory diseases; while they offer little resistance to microbial infection and frequently present the cutaneous and nervous symptoms of arsenical poisoning. A characteristic feature of the continued use of arsenic in many instances is the imparting to the breath and sweat of the odor of garlic. The excretion of arsenic takes place so slowly that the drug may be discovered in the urine five months after the last dose has been taken, and it is well known that arsenic may be found many years after death in the bodies of those who have taken it during life. Even in toxic doses, however, it is not always capable of preserving the body from corruption, since in the intestines of persons who have been poisoned with arsenic trioxide, examined some months after death, the poison has been found in the state of arsenic sulphide, into which it has been converted by the hydrogen sulphide developed by the putrefactive process taking place in the bowel.

Untoward Effects.—In very susceptible persons there have occasionally been noticed, from the use of medicinal doses, certain effects which differ from the ordinary symptoms of chronic or arsenical poisoning. Among them may be mentioned restlessness, headache, alopecia circumscripta, bronchitis and hoarseness; more rarely, epistaxis, amblyopia, and anaphrodisia.

THERAPEUTICS OF ARSENICAL COMPOUNDS.

External.—Arsenic trioxide, either pure or as a paste, was formerly much more used than at present as a caustic for destroying growths of various kinds. Marsden's paste consists of arsenic trioxide, 1; powdered acacia, 2 parts. Another paste which was once very popular consisted of arsenic trioxide, 1; charcoal, 1; red mercuric sulphide, 4 parts; and water sufficient to make a paste. Unless it is used in sufficient strength to make the mass of dead tissue slough out quickly, there is danger of the patient becoming poisoned, as the arsenic is rapidly absorbed. A caustic powder may be made of arsenic trioxide, 1; calomel, 8; antimony sulphide, 8 parts. Liquor Potassii Arsenitis is sometimes used as an application for corns. Arsenous iodide in ointment (1 to 12) has been found a valuable stimulating application in old dry eczema. For lupus it may be made stronger, or may be combined with mercuric chloride. Mercurial ointment containing from 5 to 10 per cent. of arsenic has been advised for warts. Arsenic trioxide is now much employed for killing the nerves of teeth. As this requires several days, it illustrates the slowness of the corrosive action of arsenic.

Internal. *Alimentary Canal.*—A course of arsenical treatment should always be commenced with small doses; for instance, .20 to .25 c.c. (3 or 4 ♏) of Liquor Potassii Arsenitis, or .001 to .0015 gm. ($\frac{1}{60}$ to $\frac{1}{40}$ gr.) of arsenic trioxide in pill or tablet. The dose should usually then be gradually increased. In this way the gastric pain, nausea, diarrhœa and other symptoms of poisoning which the drug is liable to produce may be avoided. Another precaution which should commonly be observed is to administer arsenic immediately after eating, in order that it may be diluted by the contents of a full stomach. When the dose used is minute, however, it is often best to give it before meals. As a rule, children bear arsenic well, while the aged do not. As arsenic increases the appetite, it is useful as a tonic in many conditions, and it is also found of service in some forms of dyspepsia. Small doses sometimes check vomiting, and especially that variety in which there is simple regurgitation of the food. Liquor Potassii Arsenitis, in doses of .06 or .12 c.c. (1 or 2 ♏) before each meal proves efficient in some cases of the vomiting of pregnancy, as well as in the vomiting of chronic gastric catarrh, especially the alcoholic form. It is also very beneficial, given in the same way, in what is known as irritative dyspepsia, which is characterized by a red and pointed tongue, poor appetite, and distress after meals, the presence of the food causing intestinal pain, and the desire to go to stool. Arsenic in these small doses is furthermore of service in chronic gastric ulcer and also in cancer of the stomach, where it diminishes the pain and checks the vomiting; while gastrodynia and enteralgia, when idiopathic, are often promptly relieved by it. In the treatment of stomach disorders it must be borne in mind that only small doses are admissible, as larger ones will serve to irritate the mucous membrane, and thus defeat the end in view. Occasionally it will be found that arsenic is capable of controlling diarrhœas which prove unamenable to other remedies. It is especially useful in that form of diarrhœa dependent upon an intolerance of the presence of food, where the undigested aliment is evacuated soon after it is swallowed. Chronic diarrhœa and dysentery, particularly when due to malarial cachexia, may also often be greatly benefited by it. In these cases it is best to give .12 c.c. (2 ♏) of Liquor Potassii Arsenitis with .30 c.c. (5 ♏) of laudanum before meals. Arsenic has even been proposed as an appropriate remedy in Asiatic cholera. In cases of constipation where there is deficient intestinal secretion, with dry fæces, it sometimes acts well. It has proved of service in catarrhal jaundice, and is especially recommended when the trouble is of malarial origin.

Remote Effects.—Arsenic is used to some extent in the treatment of anæmia, and especially in cases of what is designated as primary anæmia, including leukæmia, exophthalmic goitre, Hodgkin's disease, and pernicious anæmia. It may perhaps prove of service, but in these conditions all remedies sometimes seem without effect. In chlorosis and in cases of anæmia where iron disagrees with the patient or proves unsuccessful it is worthy of trial, and is here considered by some clinicians one of the most valuable agents in the pharmacopœia. In these disorders the efficiency of iron is at times much increased by the addition of arsenic. Although much inferior to that drug, it is next to quinine the most efficient remedy in malarial infection which we possess. It is in chronic cases that it is especially beneficial. Reference has already been made to its value in intestinal disorders due to such infection, and it is also of service (though distinctly less than quinine) in various other affections when of malarial origin, such as hemicrania and other neuralgias. As a prophylactic against malaria some of the observations made apparently indicate that arsenic is superior even to quinine. In a considerable number of nervous conditions, whether there is a malarial taint present or not, it is of value. Among these may be mentioned cerebral congestion, melancholy and hypochondria of the aged, and especially chorea. In the latter it should be given in rapidly increasing doses. In paralysis agitans, as well as in local chorea and histrionic spasm, the subcutaneous injection of Fowler's solution or Pearson's solution of sodium arsenate (solution of sodium arsenate, 1; distilled water, 9) has sometimes proved of great service. Arsenic employed by this method is also an efficient remedy in lymphadenoma and in malarial hypertrophy of the liver and spleen, and has been known to be successful in obstinate cases of general malaria which have resisted the action of quinine. Used either internally or locally (often by fumigation in the form of arsenical cigarettes) arsenic is useful in chronic bronchitis, emphysema, spasmodic asthma, "hay asthma," chronic pneumonia (fibroid phthisis), and even pulmonary tuberculosis when the course of the disease is very slow. Arsenous iodide, .30 c.c. (5 ♏) after each meal of a 1 per cent. solution, increased to .90 c.c. (15 ♏) or 1.20 c.c. (20 ♏), has been found of value in the bronchitis of strumous children. In both acute and chronic coryza the fumes of arsenical cigarettes, snuffed into the nares, are of service. Such cigarettes may be made by saturating bibulous paper in a solution of 1 gm. (15 gr.) of potassium arsenate to 30 c.c. (1 fl. oz.) of water. In short breathing from cardiac weakness, especially in elderly persons, arsenic is apt to afford relief, and attacks of angina pectoris may sometimes be lessened or prevented by the persistent use of the drug in the interval. A course of arsenic often has a valuable tonic influence in organic heart disease, and under its use dyspnœa, palpitation, intermittency of the pulse, and œdema improve. It has been found very useful in a certain form of chronic arthritis, in which the joints become stiff and painful in consequence of a peculiar state of the nervous system; the trophic nerves being involved and the condition one allied to neuralgia. As to its value in the kind of chronic rheumatism or rheumatic gout which is accompanied by nodosities of the joints authorities differ. By some it is claimed that it is of considerable service in those forms of chronic rheumatism in which potassium iodide is commonly employed, and that it is often advantageous to administer these two alteratives alternately for periods of three or four weeks. Arsenic has been employed with good effect in albuminuria following scarlatina, and also appears to be useful in certain forms of chronic albuminuria. It is thought to be of considerable value in diabetes of hepatic origin, and at the present time Clemens' bromide solution (consisting of a solution in water of arsenic trioxide, bromine and potassium carbonate) is much in favor as a remedy for diabetes. Good results have also been claimed from the persevering use of small doses of arsenic in cirrhosis of the liver, in epithelioma, and in rodent ulcer, while some have believed that it is useful in scirrhus, especially as the disease manifests itself in the stomach, and in retarding the growth of uterine cancer. There appears to be good evidence that arsenic in large doses restrains the growth of sarcomata, particularly of the fusiform-cell variety.

One of the most useful and general applications of the drug is in the treatment of diseases of the skin. As it exerts its influence chiefly upon the epidermis, its action being upon nutrition through the nerves, diseases affecting the more superficial strata of the integument are most amenable to it, while it produces a less marked effect upon those having their seat in the deeper structures. It should not be employed when there is great heat, burning, intense itching, or rapid cell-change, and should therefore rarely be prescribed in the acute inflammatory stage of any cutaneous affection. It is of great value in many cases of psoriasis, in certain varieties of eczema, especially in chronic squamous and papular forms of the disease, in acne of the small papular variety, especially in neurotic cases, in certain glandular hypersecretory diseases of neurotic origin, such as seborrhœa and hyperidrosis, in lichen, and in pemphigus. It should be avoided in acute eczema unless the case is distinctly neurotic. It is sometimes of service in chronic urticaria, and also in morphœa, alopecia circumscripta, and other atropic diseases. Dermatologists hold that in all diseases of the skin before arsenic is prescribed the digestive tract should be carefully investigated, and if any abnormal condition is shown, that this should be rectified. It is sometimes found that syphilitic affections can be better treated by the combination of mercury with arsenic than by mercury alone, and Donovan's solution (Liquor Arseni et Hydrargyri Iodidi) is especially useful in old syphilitic skin lesions. Furunculosis may be successfully treated by the persistent use of arsenic, and small doses of it are said to have a curative effect upon warts. Given in association with the bromides, it is useful in lessening or preventing the disfiguring acne which so frequently results from the continued administration of these drugs.

The springs of Levico and La Bourboule contain arsenic trioxide. Strong Levico contains .005 gm. ($\frac{1}{12}$ gr.) of arsenic trioxide and 2 gm. (30 gr.) of iron to 500 c.c. (1 pint); weak Levico, .0005 gm. ($\frac{1}{120}$ gr.) and 0.5 gm. (8 gr.) respectively. La Bourboule contains .005 gm. ($\frac{1}{12}$ gr.) of arsenous acid and a trace of iron to 500 c.c. (1 pint). These waters should always be taken with the meals.

Cacodylic acid, $AsO(OH)O(CH_3)_2$ (not official) and sodium cacodylate, $AsONa(CH_3)_2$ (not official) have recently been proposed as eligible methods for the administration of arsenic. The former contains 58 per cent. of arsenic. Their solubility, relatively small toxicity, and the diminished local irritation which they produce are advantages to be borne in mind. The best form of administration is as sodium cacodylate, given hypodermatically in daily amount of from .05 to 15 gm. (¾ to 2½ gr.), in solution. By this method the arsenic is fully efficacious, no alliaceous odor is given to the breath or perspiration, and gastric and intestinal disturbances do not supervene. Prolonged use, however, may set up albuminuria. By the rectum it produces less irritation and the odor of garlic is not so pronounced as after the use of Fowler's solution. This method is preferable in the treatment of tuberculosis, diabetes, Basedow's disease, and leukæmia. It has been objected against the use of the cacodylates that if they can be administered in comparatively large doses without producing characteristic symptoms of the action of arsenic, it must be because the arsenic ion has been rendered inert; the reason for this probably being that in these substances there is formed so firm and stable a union of the arsenic with other ingredients that no dissociating influence to which it is subjected in the body is capable of setting free the active arsenic ion from the combination. It is also claimed that in several diseases in which the older arsenical compounds are given with advantage no therapeutic results assignable to arsenic have been obtained from the cacodylates; and, furthermore, that when these are administered, they pass through the system and are eliminated in such stable combinations with organic bodies that they fail to react to the usual tests for arsenates, and fail to yield arsenic when subjected to the dissociating influence of Marsh's process. To these objections it may be answered that while the cacodylates are absorbed but slowly and the arsenic ion is dissociated with difficulty, they do produce distinct arsenical effects in the body, as has been unquestionably shown by the fact that cases are on record in which poisoning with the characteristic symptoms of arsenic has occurred. In addition, this has been demonstrated by the fact that in some diseases, at all events, in which the ordinary compounds are known to be efficient, equally good results have been obtained from the use of the cacodylates. In seeking for a cause for this discrepancy between observers attention should be called to the fact that the strongest objection to the use of the cacodylates has been made by those who have administered them by the mouth. When given hypodermatically several disadvantages are obviated; the garlic-like odor of the breath, intestinal irritation, etc.

TOXICOLOGY.

Acute Poisoning.—Arsenic is used to a very considerable extent for poisonous purposes. The forms most employed are Scheele's and Paris Green (cupric arsenite), and Schweinfurth's Green (a compound of cupric arsenite and arsenate). *Symptoms.*—As the pathology of the effects of arsenical salts in the alimentary canal is practically the same as that of Asiatic cholera, so the symptoms of poisoning by them generally resemble very closely those met with in that disease. Large doses frequently produce no distress for a considerable time, but in the course of half an hour, or perhaps longer, the patient experiences a sense of constriction in the fauces, with dysphagia. About the same time he begins to suffer from slight epigastric pain, which soon becomes extreme, and spreads over the abdomen. It is accompanied with faintness, nausea and excessive vomiting, and later by profuse watery diarrhœa, with tenesmus and intense thirst. The matter vomited and the stools may contain blood, but this is not infrequently absent. The patient also suffers from muscular cramps, headache and dizziness, and gradually sinks into collapse, with coldness of the extremities, pallor, small and feeble pulse, and sighing respiration. This condition passes into one of coma, followed by death, which may or may not be preceded by convulsions. Exceptional cases have been noted in which the only symptoms were those of collapse and coma. Death may perhaps occur within twenty-four hours, but more commonly the vital powers are not exhausted for considerably longer than this, and the patient may linger for several days. Not infrequently it is found to be the case that he recovers from the acute symptoms only to develop those of chronic arsenical poisoning.

Post-mortem.—The mucous membrane of the gastro-intestinal tract is generally red and swollen, while its epithelial coat in many places can be readily detached and is found to be in a state of fatty degeneration. As a rule, no erosion is observed unless the arsenic has been swallowed in powder, when, if the latter has remained for some time in contact with the wall of the stomach, there may perhaps be some erosion, as well as more marked congestion, as the result of its local action. In the intestine the swelling and congestion of the mucous membrane is most pronounced around Peyer's patches, and the bowel generally contains a considerable quantity of thin fluid with flakes of membrane, like the rice-water discharges of cholera. Hæmorrhage is only occasionally met with, but in both the stomach and intestine small particles of arsenic are not infrequently observed.

Treatment.—It is important that the stomach should be completely emptied as soon as possible, either by washing out or the use of emetics (*see* p. 159), choice being made of those least depressing and least irritating. On account of the insolubility of arsenic it is advisable that the stomach washing should be continued for some time. At the same time large quantities of freshly prepared ferric hydroxide with magnesium oxide (*see* pp. 201, 208) or dialyzed iron should be given; if these cannot be obtained, magnesia (preferably light magnesia) shaken up with water. The antidote must be repeated at intervals as long as the acute symptoms continue. If neither magnesia nor the iron preparations are procurable, dependence must be placed on large doses of castor oil and water. For the collapse, subcutaneous injections of brandy or ether may be given, and warm applications made to the abdomen and extremities.

Chronic Poisoning.—When arsenic is given medicinally, too large doses may induce slight symptoms of poisoning, such as abdominal pain, loss of appetite, nausea, indigestion, mild diarrhœa, puffiness of the eyelids, injection of the conjunctiva, and watering of the eyes and nose.

Cutaneous eruptions are also sometimes caused, and while these may be due in part to circulatory derangements, they are believed to result chiefly from a direct action of the drug on the skin. They may be erythematous, papular, vesicular or pustular in character, and may be attended with erysipelatous swelling. Herpes zoster, it is said, has been caused by its prolonged administration. As arsenic is very extensively used in the arts, particularly in the manufacture of wall papers and fabrics, accidental poisoning is not infrequent among workers in arsenic and may occur in persons using articles which contain it. The evidence in regard to chronic poisoning from occupancy of rooms decorated with arsenical wall paper is somewhat contradictory, but the facts point towards its probability. Quite as often the poisoning is due to the arsenic which is a contamination of aniline dyes as it is to the arsenical pigments, so that the color should not be depended upon, but rather a chemical examination.

As the arsenical poisoning goes on, a catarrhal condition of the mucous membrane of the nose and throat is developed, with much sneezing and coughing, cutaneous eruptions of various kinds appear, and, in some instances, a curious pigmentation of the skin occurs (arsenic melanosis); while eventually the hair and nails fall out. Swelling of the liver, with jaundice, is sometimes met with, and the later phases of the disorder are characterized by sensory and motor disturbances in localized areas (generally in the hands and feet), the result of polyneuritis. There are acute pain and formication in the extremities, followed by sensory paralysis, with symptoms resembling those of locomotor ataxia. This again is succeeded by motor paralysis, which as a rule is confined to the extremities, but may possibly invade the trunk. It is generally symmetrical and the affected muscles (more commonly the extensors than the flexors) atrophy quite rapidly. Herpes of the face or trunk, of nervous origin, is a common symptom. In very prolonged cases the patient may sink into an apathetic, semi-idiotic condition, or may become epileptic. After death from chronic poisoning, in addition to the gastro-intestinal and nervous lesions, there is found fatty degeneration of most of the organs of the body, and particularly the liver, kidneys, stomach and muscles, including the heart.

The tests for arsenic are so simple that every physician should be able to make use of them. They are: (1) Reinsch's.—Hydrochloric acid and a clean slip of copper are boiled in the suspected liquid. Bluish spots indicate the poison. (2) Marsh's.—Diluted sulphuric acid and zinc are introduced into a flask with the suspected liquid. The gas issuing from the tube is ignited and the flame allowed to impinge upon a clean porcelain plate forming a steel-white mirror if arsenic be present; or the delivery tube may be heated when the mirror will be deposited upon it. This mirror is distinguished from that produced by antimony by its solubility in potassium hypochlorite if arsenic is the cause.

DIVISION III.—DRUGS ACTING ON THE CARDIAC MECHANISM.

While it was formerly supposed that the spontaneous impulses originating in the heart, which normally commence in the sinus venosus and extend downwards over the auricle and ventricle to the apex, had their birth in the cardiac ganglia, the real function of these ganglia (which may possibly be a nutritive one) is still practically unknown, and there is now at command considerable evidence to the effect that it is in consequence of impulses originating in themselves that the muscular fibres contract. The contractile function of the muscular fibres is, however, subject to two opposing influences, one that of the accelerator nerve-fibres connected with the sympathetic, which tends to augment it, and the other that of the pneumogastric, or vagus, which tends to inhibit it. In studying the effects of drugs on the heart, therefore, all that we are called upon to consider is their action on the muscular structure of the heart, on the nerve-fibres distributed to it from the vagus and the sympathetic, and on the vagus and accelerator centres in the medulla oblongata. These centres, it may be stated, are extremely sensitive to afferent impulses conveyed from various parts of the body, as well as from the heart itself. Our knowledge of the action of drugs upon the human heart is necessarily somewhat imperfect, since it is principally derived from experimentation on animals, in connection with which there are a number of difficulties and sources of error. Thus, many experiments cannot be satisfactorily made upon the mammalian heart, and hence the cold-blooded animals have been made use of to a large extent. As some differences have been observed among them (as, for instance, between the frog and the tortoise) it is a question how far deductions from experiments upon the hearts of warm-blooded animals, among which, again, decided differences are sometimes found, are applicable to the human heart. A uniformity of effect will naturally go far to establish the character of any given action as regards man, but in general we have to depend largely on probabilities in this matter. Attention may here be directed to one point of interest: the action of a large dose of a drug is as a rule the opposite of that of a moderate dose.

A. Drugs Acting Upon the Heart Directly.—Our knowledge of these has been derived from the application to the heart of a solution of the drug externally, or by means of a transfusion canula, and by the action of the drug upon the excised heart or section of a heart. Since the apex probably contains no nerves, it is customary to conclude that if a drug has an action on the isolated apex it acts exclusively upon the muscle; but as it is always a difficult matter to decide whether a drug acts upon the muscle fibre itself or upon the fine nerves between the fibres, it will be found advisable to make no attempt to distinguish between these actions. In studying the nervous influences affecting the heart's action much more attention has been paid to the inhibitory or vagus than to the accelerating mechanism. The effect of stimulating the muscle is the same as that of stimulating the accelerator fibres, and consists in an augmentation of either the rate or the force of the beat, or both. On the other hand, stimulation of the vagus fibres or its cardiac terminations may cause a diminution in either the rate or the force of the beat, or both; while the paralyzing of either the accelerator or vagus terminations naturally produces an effect just the opposite to their stimulation. As it is very difficult to decide whether drugs act upon the muscle or on the nerve-endings, it will be most convenient to classify those which act locally on the heart by the effect they produce, without reference to this point.

Drugs increasing the force of the contraction:

(1) **Digitalis.**
(2) **Strophanthus.**
(3) **Adonidin.**
(4) **Squill.**
(5) **Convallaria.**
(6) **Caffeine.**
(7) **Veratrine.**
(8) **Erythrophlœum.**
(9) **Barium Salts.**

In frogs these drugs, in large doses, always cause arrest of the heart in systole; in mammals the final arrest may be in diastole with some, *e. g.*, digitalis. **They all slow the pulse.**

(10) **Camphor.**
(11) **Musk.**
(12) **Dilute solutions of copper double salts.**
(13) **Dilute solutions of zinc double salts.**
(14) **Dilute solutions of hydrated chloral.**
(15) **Physostigmine.**

These drugs have the same action without the final arrest in **systole.** The rate of the pulse is not so markedly altered.

Drugs the chief action of which is to decrease the force of the contraction, usually with stoppage in diastole:

(1) **Diluted acids.**
(2) **Strong solutions of salts of the alkaline metals.**
(3) **Strong solutions of barium salts.**
(4) **Strong solutions of copper double salts.**
(5) **Strong solutions of zinc double salts.**
(6) **Strong solutions of hydrated chloral.**
(7) **Muscarine.**
(8) **Pilocarpine.**
(9) **Saponin** (large doses).
(10) **Apomorphine.**
(11) **Emetine.**
(12) **Salicylic acid** (large doses).

Drugs an important action of which is to increase the rate of the cardiac beat:

(1) **Atropine.**
(2) **Hyoscyamine.**
(3) **Daturine.**
(4) **Duboisine.**
(5) **Cocaine.**
(6) **Saponin.**

Drugs an important action of which is to slow the rate of the cardiac beat (see also first list given above):

(1) **Muscarine.**
(2) **Pilocarpine.**

Drugs which increase both the force and the number of the beats:

(1) **Ammonium salts.**
(2) **Alcohol.**
(3) **Ether.**
(4) **Chloroform.**
(5) **Cactus.**
(6) **Anæsthetics.**
(7) **Arsenical salts.**
(8) **Quinine.**
(9) **Strychnine.**

Drugs which decrease both the force and the number of the beats:

(1) **Antimony salts.**
(2) **Aconite.**
(3) **Hydrocyanic acid.**
(4) **Ergot.**
(5) **Veratrum.**

B. Drugs Acting on the Vagus Centre.—It may be concluded that a drug acts on the vagus centre when it is found that while it has the effect of altering the beat of the heart, such alteration may be counteracted either by section of the vagi or by stimulation of the peripheral end of the nerve, if only one of the vagi be cut.

Drugs which stimulate the vagus centre: that is to say, the pulse is slowed, but this slowing disappears on section of the vagi:

(1) **Chloroform.**
(2) **Hydrated Chloral.**
(3) **Butyl-chloral hydrate.**
(4) **Aconite.**
(5) **Veratrum.**
(6) **Nicotine.**
(7) **Digitalis.**
(8) **Sparteine.**
(9) **Strophanthus.**
(10) **Squill.**
(11) **Convallaria.**
(12) **Hydrocyanic acid.**
(13) **Cocaine** (large doses).
(14) **Staphisagria.**
(15) **Atropine**
(16) **Hyoscyamine** } Only very early in their action.
(17) **Daturine**
(18) **Increased blood-pressure.**
(19) **Venous blood.**

Drugs which depress the vagus centre: Large doses of the drugs mentioned in the last list, and drugs which diminish the blood-pressure, such as amyl nitrite, nitroglycerin and the nitrites.

C. Drugs Acting on the Accelerating Centre.—So far as known, there are no drugs which have the effect of depressing this. Probably some stimulate it, for their administration renders the pulse still more rapid after the vagi have been cut.

They are—

(1) **Ammonia.**
(2) **Caffeine.**
(3) **Picrotoxin.**
(4) **Cactus.**
(5) **Staphisagria.**
(6) Any drugs which make the blood venous.

Therapeutics.—The drugs most used for their action on the heart are digitalis, strophanthus, ammonium salts, sparteine, squill, convallaria, caffeine, alcohol, ether, chloroform, cactus, strychnine, belladonna, aconite, antimony and hydrocyanic acid. The various indications for which they are severally given will be mentioned under each drug.

A. Drugs Acting Upon the Heart Directly.

DIGITALIS.

DIGITALIS.—Digitalis. (Foxglove.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Extractum Digitalis.**—Extract of Digitalis. **Dose, 0.010 gm. = 10 milligm. (⅕ gr.).**

2. **Fluidextractum Digitalis.** — Fluidextract of Digitalis. **Dose, 0.05 c.c. (1 ♏).**

3. **Infusum Digitalis.**—Infusion of Digitalis. **Dose, 8 c.c. (2 fl. dr.).**

4. **Tinctura Digitalis.**—Tincture of Digitalis. **Dose, 1 c.c. (15 ♏).**

Unofficial Preparations.

Digitalinum.—Digitalin. **Dose, 1 mg.; $\frac{1}{64}$ gr.**

Digitoxinum.—Digitoxin. **Dose, .00025 to .00032 gm.; $\frac{1}{250}$ to $\frac{1}{200}$ gr.**

ACTION OF DIGITALIS.

External.—It has but little effect on the skin; its principal local action being on the mucous membranes, where the primary irritation caused by it is not infrequently followed by paralysis of the nerve endings.

Internal. *Gastro-intestinal Tract.*—It causes **gastro-intestinal irritation**, and in large doses gives rise to gastritis and purging, with green stools. There is some ground for supposing that these disturbances are in part at least of **centric origin.**

Blood.—It has no appreciable effect upon the blood.

Heart.—Digitalis has a pronounced effect upon the heart. This is due principally to its **direct action** on the **cardiac muscle**, but also, in part, to **stimulation** of the **vagus** apparatus, both in the medulla and peripherally. Applied locally to the heart of a frog, digitalis is capable of causing tonic contraction of the organ. It will also increase the force of the contraction when applied to the isolated apex, in which no nerves are believed to exist, and act on the embryonic heart of the chick before the nerves are developed.

The influence digitalis exerts may be divided into three stages. In the first, or therapeutic, stage the **rhythm** of the heart is markedly **slowed**, and the ventricles, emptying themselves more thoroughly than under normal conditions, become diminished in size. As the contraction of the ventricle is more complete, the blood is expelled into the vessels under greater pressure than normally. Relaxation of the ventricle during diastole is also increased in the healthy heart, but if the organ is weak and dilated, digitalis tends to diminish the relaxation. The auricles are slowed, as well as the ventricles, but in general they are not so much affected as the ventricles. The **diastole** is **prolonged**, the **force of the systole increased**, and the size of the individual pulse-wave also increased. If the heart is beating at its normal rate the diastole is increased by digitalis, but if the beat is slow, and the slowness is due to weakness of the cardiac muscle, the diastole is diminished instead. The slowing of the pulse caused by the drug is apparently due to a simultaneous stimulation of both the central and peripheral vagus apparatus, since it has been demonstrated that in the mammal the administration of atropine entirely does away with this slowing. Moreover, if section of the vagi is made, the slowing is much less than when these nerves are left intact, and may be altogether absent. Under digitalis the **work** done by the heart is much **greater than normal**, and the slowness developed is not sufficient to counterbalance the increased output at each ventricular contraction.

In the second stage the pulse is very slow and irregular, for the reason that the inhibitory mechanism is powerfully stimulated. During diastole the ventricle dilates more completely than usual, while its systole varies in force. The contraction of the auricle becomes much weakened, and sometimes the rhythm of the latter is different from that of the ventricle. Under certain circumstances this stage may be absent.

The third stage is always developed if a sufficient quantity of the drug be given. In this the heart's action becomes extremely fast and irregular. This accelerated rate is believed to be due, not to paralysis of the pneumogastric centres and cardiac peripheral filaments, but to such an increased excitability of the heart muscle that the inhibitory apparatus can no longer hold it in check. The rhythm of the ventricle continues to increase, but the strength of its contractions diminishes. The output of the heart continues much augmented during the first part of the third stage, and then rapidly declines. The auricle passes into the condition known as delirium cordis, and finally the ventricle also. Then the circulation is arrested; after which the heart dilates to an extreme degree.

The action of digitalis on the heart has been very carefully studied in the frog, and it is found that in general its effects on the mammalian heart resemble those on the batrachian. The contraction, however, is not prolonged as it is in the latter, and the inhibitory action is of greater importance. In the frog the drug causes systolic arrest of the heart, while in man the arrest is in diastole. The reason for this difference is supposed to be that the mammalian heart is not capable of continuous systole.

Vessels.—Digitalis has the effect of markedly **increasing** the **blood-pressure** in the vessels. Three factors are concerned in producing this result, namely: The **expulsion** from the heart of **more blood than usual** and at a higher pressure, the **stimulation** of the **vaso-motor centres**, and the **direct action** of the drug **on the vessels** themselves, exciting a condition of abnormal activity in their muscular coats, and thus diminishing their calibre. If digitalis is injected into a frog and a small artery in its foot is measured, it will be found that during the action of the drug the calibre of the vessel is diminished to about three fourths its natural size; and the mammalian kidney is also found to decrease in size under digitalis. That the constriction of the arteries from digitalis is to a great extent a muscular action is shown by the fact that it occurs in organs which have been excised, even for several hours; but, as this constriction is not as marked as when the drug is administered under normal conditions, the agency of the vaso-constrictor centres must also be recognized. While the blood-pressure rises in the arteries, the velocity of the current diminishes, and as the pressure rises in the arteries it declines in the veins; both these effects indicating an increased resistance.

Under toxic doses of digitalis the blood-pressure in the vessels diminishes with the extreme slowing of the heart, but as the latter becomes accelerated it again rises to a pronounced degree; this result being due to the quickened heart and contraction of the arterioles. Then, as the heart becomes irregular, the blood-pressure declines until it finally reaches zero when the heart stops. This fall results from the decreasing efficiency of the cardiac contractions and from vaso-motor paralysis.

Some former experiments, made for the purpose of demonstrating the action of digitalis and its allies upon the vessels, have recently been repeated. The new experiments were conducted on dogs. Two entirely different methods were employed: in one the amount of blood flowing out of the veins of different regions was registered after a sufficient amount of atropine had been given to overcome the slowing of the pulse; in the other the plethysmograph was used. The experiments showed that the increased blood-pressure is due to increased heart action and contraction of the vessels, and that the latter is due to peripheral action which, in the case of digitoxin, is general. In the case of the other glycosides examined (digitalin, convallamarin, strophanthin) the action is restricted to the splanchnic area. There is, however, some active constriction going on here in the peripheral vessels, yet this is overcome by a passive dilatation, owing to reflux of blood from the intestines and an active reflex dilatation set up by the splanchnic contraction. The general narrowing of the pathway of the blood seen with digitoxin gives a high resistance which must be overcome by the heart; strophanthin, etc., open the vessels of the periphery, and this materially relieves the organ.

Kidney.—In dropsy, especially when due to cardiac disease, there is no question as to the value of digitalis as a diuretic, though its action has been explained in a variety of ways. It has been disputed, however, whether in health it has any effect on the renal secretion. The weight of authority seems to favor the view that it does exert some **diuretic** action, but this has proved so variable as to lead to the conclusion that it is probably, to a large extent at least, of an indirect, rather than a direct, nature. Nearly all are agreed that the kidneys are affected principally through changes in the circulation, and perhaps the most satisfactory explanation of this is that the diuresis is due to the cardiac action of the drug. Under this hypothesis it is supposed that arterial accumulation, with diminished venous pressure, leads to an increased flow of lymph into the blood-vessels. The blood is thus diluted, and the kidneys incited to special activity, while at the same time the nutrition of the organs is improved. In addition to this indirect action, there is some ground for believing that digitalis exerts a limited influence directly upon the renal epithelium, on which it probably acts as a mild irritant. By the diuretic action of the drug the fluid of the urine is said to be much more largely increased than the solids. As to its effect upon the urea and other urinary constituents, the reports of various observers have been so conflicting that no definite conclusions can be arrived at.

Temperature.—In health, digitalis, in medicinal doses, has little or no effect on the temperature. In febrile conditions it has an antipyretic action, but this is somewhat uncertain. Toxic doses cause a sustained reduction of temperature, amounting to several degrees, but their first effect is to increase it. It is thought by some that this temporary elevation may be due to the local irritation of the drug, and that if this can be avoided the fall will occur without the antecedent rise. Others explain the phenomena observed as follows: Owing to the increased resistance from diminution of the calibre of the arterioles, the actual energy expended by the heart is in part converted into heat. Subsequently the slowing of the circulation, especially through the lungs, hinders the combustion process, and hence the fall of temperature.

Respiration.—It has little or no effect on respiration unless taken in toxic quantity, when, it is said, the respiratory movements become deep and rapid from central nervous stimulation.

Nervous System and Muscles.—In therapeutic doses the only effect of digitalis appears to be the stimulation of the inhibitory cardiac and the vaso-motor centres in the medulla oblongata. Toxic doses, however, stimulate other centres, and general convulsions may eventually result. They diminish reflex activity by directly exciting the reflex inhibitory centres of Setschenow in the medulla, and afterwards by depressing the spinal cord. Finally the motor nerve-trunks are depressed and the muscles are paralyzed. While the cerebrum is not directly affected by digitalis, the disturbances in its circulation caused by the drug are liable to give rise to severe headache, excessive vomiting, dizziness, vertigo, confusion of sight, and possibly hallucinations and delirium. In some instances the whole field of vision is said to be blue and in others yellow. Exophthalmos occurs, and a peculiar blue color of the sclerotic has been quite constantly noted in acute poisoning.

Uterus.—Digitalis appears to have some influence on the non-striated muscular fibres throughout the body, and it thus acts like ergot in causing contraction of the uterus.

THERAPEUTICS OF DIGITALIS.

External.—Digitalis is sometimes used externally in the form of a poultice made from the leaves, and placed over the loins in cases of renal congestion. It has also been found serviceable in chilblains, in the form of a lotion in which tincture of digitalis is combined with thymol, alcohol and glycerin.

Internal.—The most important use of digitalis is in affections of the heart, in which it is of very great value. It is indicated, in general, when the cardiac action is rapid and feeble, with low arterial tension, and contra-indicated when the cardiac action is strong and arterial tension high. It not only slows and steadies the heart, but also improves the nutrition of its walls by its stimulating influence on the pneumogastric nerve, as well as by increasing the blood supply of the heart muscle by rendering the systole more complete and prolonging the diastole. By its action the pressure in the coronary arteries is increased, and more time allowed for their filling. The benefit derived from the drug in not too inveterate cardiac disease is often in a measure permanent, by reason of the assistance which it affords in the production of compensatory hypertrophy. The relief of the circulation caused by it may in time bring about permanent nutritive changes in the heart-muscle, which is stimulated to such a marked degree by it, and dilatation is clearly less apt to occur when the muscular fibre is toned up and acting vigorously than when it is lax and acting feebly. The constriction of the peripheral vessels caused by it has been thought by some to constitute a valid objection to the use of digitalis, but this may not really be sufficient to seriously interfere with the increased cardiac power secured, while if such is the case, it may be counteracted by means of drugs having an opposing action, as will be more particularly dwelt upon later.

Cumulative Effect and Contra-indications.—Digitalis should always be administered with caution, and it is advisable to commence with small doses, which may afterwards be gradually increased, if necessary. A patient taking full doses of the drug should preferably be kept in the recumbent posture. When, under its influence, the pulse has become much reduced, on rising the heart is sometimes suddenly found unequal to maintaining the circulation in face of the increased resistance in the arterioles, and against the force of gravity; so that fatal syncope may occur. Digitalis should always be stopped as soon as symptoms of gastro-intestinal irritation supervene, or the pulse becomes abnormally slow. In case the tincture is employed, what is known as the fat-free tincture of digitalis will be found less likely to disagree with the stomach than the official preparation. In this the fixed oil of the leaf and its free acids are eliminated. It must not be forgotten that digitalis has a cumulative effect, and this is probably due to vaso-spasm and to the fact that if the drug is too closely pressed it is not excreted by the kidneys as fast as it is absorbed, and consequently accumulates in the system. It sometimes happens, therefore, that, without any increase in the dose, individuals who have been kept on digitalis for a long period suddenly develop symptoms of poisoning by it. Such an untoward result may be avoided if the doses are given at proper intervals; the effects of each being allowed to subside before the next is administered. The plan has been adopted by some of stopping the remedy for several days at the end of each week. Others continue it for ten days, then intermit for four days and begin again. It should be kept up no longer than is necessary to re-establish compensation. Digitalis is contra-indicated in cases where, with dilatation there is extensive degeneration of the muscular wall, as the muscle is likely to be too weak to respond to its stimulus. Under these circumstances, the digitalis increasing the pressure against which the heart has to contract, the most serious results may occur. Thus the systole becomes even weaker than before its administration, and cerebral anæmia, syncope, and perhaps sudden death may ensue. Some individuals are unable to take digitalis at all, on account of the nausea which it produces.

Mitral Regurgitation.—It is especially valuable in those cases of mitral disease in which compensation (that is, the adaptation of the organs of circulation to the unusual conditions imposed upon them by the valvular lesion) has begun to fail. In mitral insufficiency the good effect caused by it is principally due to its tonic action in tending to produce a permanent systolic condition, in consequence of which the rings of the valves are narrowed and brought together, and the orifice rendered smaller. In this way it abolishes the effects of the distention and tends to lessen the insufficiency. As regards the administration of digitalis, cases of mitral regurgitaton have been divided into three groups, as follows: (1) Those in which the ventricle is but little enlarged, while the nutrition of its muscular wall is still well-preserved, and which may be attended with perhaps no inconvenience except more or less dyspnœa (usually but slight) on exertion. (2) Those in which cardiac dropsy, of greater or less extent, is present. (3) Those in which, with extensive dilatation, there is little or no cardiac dropsy, but well-marked symptoms of pulmonary congestion. In the last two varieties digitalis is of the greatest service. By increasing the force of the left ventricle's contraction it causes the approximation of the mitral flaps, thus reducing the amount of the regurgitation and diminishing venous congestion. Under the action of the drug the increased force of the systole will throw proportionately more blood through the aortic orifice than through the partially open and obstructed mitral valve, and, the larger orifice eventually gaining on the smaller, more blood will pass into the general circulation, and the pulmonic vessels be relieved. The prolonged diastole will also be of service in allowing more time for the blood to flow into the left ventricle. Thus, both the auricles and ventricles gain increased power to empty themselves, and the longer intervals between the pulsations enable the former to more completely discharge their contents into the ventricles. The favorable action of the drug, therefore, is seen (1) in increasing the length of the diastole and thus improving the nutrition of the cardiac walls; (2) in increasing the tonic contraction of the heart, and thereby diminishing the size of the dilated cavity; (3) in increasing the force of the pulsations; and (4) in causing more slowness and regularity in the cardiac rhythm. The general improvement in the circulation caused by it has an excellent effect in relieving the cardiac pain and distress and the dyspnœa and cyanosis incident to the disease, and the more a case of mitral regurgitation is characterized by the œdematous type the more efficient will the drug prove. In addition, therefore, to its direct action on the heart, the beneficial effects of digitalis are shown in a variety of ways. One of the most prompt results of its administration is a marked increase in the quantity of urine, and hence it is of essential service in relieving cardiac dropsy. Here it not only regulates the circulation, by its action on the heart, and causes the evacuation of the surplus fluid through the kidneys, but also acts directly on the vessels by increasing vaso-motor force. In some cases the diuretic effect of digitalis is materially assisted by the administration in connection with it of an alkaline diuretic, such as potassium bitartrate or citrate, and occasionally it may be found that diuresis can be established only after free purgation. Owing to the disordered circulation, sleeplessness is often a marked symptom of serious cardiac disease. The normal relationship between the cerebral vessels and the general circulation is not maintained, and by restoring this balance digitalis gives the patient ability to sleep. The dyspnœa is relieved by the action of the drug in establishing a more efficient pulmonary circulation. By improving the venous flow towards the heart it will thus be of service in counteracting the venous engorgement and œdema of the lungs, the right side of the heart, the liver, the kidneys, and the subcutaneous tissues so commonly met with.

There are some instances of mitral regurgitation in which digitalis seems to be indicated and yet in which it proves injurious rather than beneficial. This may be due, in a portion of the cases at least, to its causing too great a strain upon the auricle. The ventricle, as has been stated, is more affected by the drug than the auricle, and as with a very patulous mitral valve the blood is readily backed upon the auricle, the latter, already too weak for the ventricle, cannot well withstand the strain imposed upon it by the ventricle thus stimulated. Conversely to the statement previously made, the less closely a case of mitral regurgitation approaches the œdematous type, the less the benefit which is likely to be derived from digitalis in it.

Mitral Stenosis.—In most cases of mitral stenosis the same benefit will attend the administration of digitalis as in cases of regurgitation. The increased resistance here leads to the same general results as the leakage in mitral insufficiency, and, like the latter, it can be successfully combated by the effect of the drug in strengthening the heart-beat. The lengthening of the diastole caused by it will allow more time for the auricle, the contracting power of which is at the same time increased, to empty itself into the ventricle through the constricted orifice. The ventricle, thus more perfectly filled, sends out more blood into the systemic circulation. In addition, the circulation is further improved by the stimulating effect of the digitalis on the right ventricle, which enables it to overcome the tendency to congestion arising from the obstruction on the left side of the heart, and affords it greater power to force the blood through the lungs. It is possible, however, that the increased work of the right ventricle, combined with the stenosis of the mitral valve, may tend to produce congestion of the pulmonary vessels, with the result of lessening the oxygenation of the blood and so interfering with the nutrition of the heart. On the other hand, the slowing of the organ will afford the lungs more time in which to empty into the heart; so that in the great majority of well-selected cases the beneficial effects of digitalis will greatly over-balance any possible evil ones. It is only necessary to add that the general amelioration of symptoms caused by it is much the same as in the case of mitral regurgitation.

Diseases of the Tricuspid Valve.—In both tricuspid constriction and insufficiency digitalis is of service in the same manner as in mitral disease, and it has been found particularly useful in cases of regurgitation with dilated right ventricle. As a rule, however, it does not appear to be as beneficial in tricuspid affections as in those of the mitral valve. As in the case of the latter, the rational signs furnish, for the most part, clearer indications for the use of digitalis than the physical. Thus, it is indicated when the cardiac action is rapid and feeble and the tension of the pulse low, and when there are cough, dyspnœa, pulsating jugulars, duskiness of the countenance, scanty, high-colored urine, and general dropsy.

Diseases of the Aortic Valve.—There is a considerable diversity of opinion as to the advisability of giving digitalis in aortic disease. While, however, a few authorities assert that its disadvantages are more than offset by its advantages, there can be but little question that in uncomplicated aortic regurgitation the drug is injurious, rather than beneficial. It increases the work of the heart, and the prolonged diastole caused by it favors the return of blood through the imperfectly closed orifice and exposes the ventricular wall to excessive strain; so that there is danger of syncope. In aortic stenosis, before compensatory hypertrophy has occurred, it may sometimes be of service. There is more or less obstruction to the normal flow of blood out of the heart, and digitalis will increase the ventricular force, so that it may overcome the difficulty. After the impediment to the circulation caused by the valvular defect has been compensated by a sufficient amount of cardiac hypertrophy it is not only useless, but may give rise to serious and even fatal results. But when aortic constriction leads to mitral incompetence and regurgitation, it may be given with advantage.

So also in aortic regurgitation, when the marked cardiac dilatation apt to be caused by the condition has given rise to mitral insufficiency, digitalis is of great value. There are other cases of aortic regurgitation in which benefit is likely to result from its use; namely, those in which there is considerable dilatation of the left ventricle, perhaps of sudden onset, and in which the prominent symptoms will be found to be shortness of breath, præcordial pain, and anxiety. While digitalis is generally contra-indicated in aortic regurgitation, especially when the latter, as is often the case, accompanies aortic constriction, yet when the heart-muscle fails and the hypertrophy is not compensatory, it is useful in both aortic insufficiency and constriction. In all cases of aortic valvular disease the effects of the drug should be very carefully watched.

It has been well said that the indication for giving or withholding digitalis in the treatment of valvular disease of the heart rests not so much upon the particular valvular lesion that is present as on the effects which have been produced by this upon the cardiac wall. A knowledge of the relation of the heart-muscle to the work required of it in any individual case is much more important, therefore, from a therapeutic point of view, than a recognition of the pathological condition of one or more of the valves. In general terms it may be stated that digitalis is of special value in all conditions in which dilatation of the heart cavities has been brought about by failure of the muscular wall as a result of valvular disease.

Constriction of the peripheral vessels which, as has been seen, is one of the chief physiological effects of digitalis, is sometimes so marked as to interfere materially with the successful use of the remedy in cardiac affections. When this is the case it may be counteracted to a considerable extent by the simultaneous administration of drugs causing vaso-dilatation, such as the nitrites. Nitroglycerin is a very useful agent for relaxing the spasm, and as its effect lasts but a short time while that of the digitalis is prolonged, it should be given at much more frequent intervals than the latter. As digitalis acts very slowly and maintains its effect for a long time, it may be sufficient, after its primary effects have been obtained, to administer it only once a day, for the purpose of continuing its influence.

Cardiac Disease Other Than Valvular.—In palpitation due to over-exertion or heart-strain, and in cardiac dilatation and asthenia, digitalis is of decided value. In the "irritable heart of soldiers," a condition associated with muscular weakness and supposed to be dependent upon exhaustion of the inhibitory nerves, it has been found better than any other remedy. When, however, cardiac hypertrophy has occurred it is of but little service. The same remarks apply to the case of those individuals who have engaged to excess in athletic exercise and who are troubled with more or less shortness of breath, but without any appreciable valvular lesion of the heart. In these cases the apex is often found to be a little outside its normal position. Digitalis is frequently prescribed in tachycardia (rapid heart), but if acceleration of the rhythm is the only symptom observed, other drugs, such as aconite, may generally be substituted for it with advantage. In functional derangements of the heart, usually the result of faulty digestion, characterized by irregularity and palpitation, digitalis is indicated and will prove of essential service if it can be given in such a way as not to disagree with the stomach. In many such subjects, however, on account of its liability to increase the indigestion, its administration is found impracticable, and the main reliance for relief of the condition must be placed on treatment directed to the dyspepsia on which it depends. In certain cases of the functional trouble met with in highly neurotic subjects it is of marked benefit, but in a large number of these it fails to give relief. It is of great value in the weakness of the heart resulting from typhoid and scarlet fevers, pneumonia, rheumatism, pericarditis and other acute diseases, even if no valvular lesion is present. The beneficial action of the drug is seen in the increased efficiency of the contractions and in the prolonged diastole, which allows more time for the cardiac muscle to rest. In these cases its effect may often be increased by combining it with caffeine or ammonia. If the latter is used, 8 c.c. (2 fl. dr.) of the infusion of digitalis may be given, with .20 c.c. (3 ♏) of stronger ammonia water, in a little water. It is often desirable to administer digitalis in combination with iron; but when its fluid preparations are associated with salts of the latter the mixture is rendered inky by the action of the iron on the tannic acid in the digitalis. This difficulty may be obviated by adding a little diluted phosphoric acid, which acts as a clarifying agent, or a pill may be used composed of powdered digitalis leaves and dried ferrous sulphate. Digitalis is also useful as a stimulant in cardiac weakness resulting from such causes as hæmorrhage, injury, poisoning and shock. In cases of this kind, on account of the slowness of its action, it should be preceded by ammonia and alcohol if the symptoms are urgent; or its slowness of action may be overcome by administering it hypodermatically. For this purpose tincture of digitalis is preferable to digitalin on account of its being much less liable to produce local irritation. Digitalis is particularly indicated in poisoning by aconite, muscarine and the nitrites, to which, as regards action on the heart, it is the physiological antidote. In organic non-valvular diseases of the heart dependent on degeneration of the cardiac muscle it should be used with extreme caution, if at all; and in many such its effects are decidedly injurious. In fatty and other degenerations, such as those resulting from alcohol and from chronic nephritis, the muscle is not in a condition to respond to the stimulation of the drug, while the peripheral resistance is increased from the vascular constriction caused by its action. Under these circumstances it is possible that some of the degenerated fibres may rupture. In dilatation of the right side of the heart associated with chronic disease of the lungs digitalis may sometimes prove of service, but this is the exception rather than the rule. In the palpitation which is often such a distressing feature of phthisis it has been found useful.

Bright's Disease.—In renal dropsy from acute desquamative nephritis (tubal nephritis) digitalis, given in the form of infusion, has been found of considerable value. While a number of days may elapse before much effect is produced, the flow of urine is sometimes enormous, and this fact is regarded by some authorities as going to show that digitalis has a direct action on the glomeruli of the kidney. Although it is not infrequently given in acute Bright's disease, however, it has been questioned whether, if it has the effect of causing dilatation of the renal arteries, it is proper to increase the circulation in any acutely inflamed organ. Furthermore, even in the early stages the arterial tension is somewhat raised, and it is undesirable to increase this. In chronic Bright's disease the arterial tension is still further increased, and as, in addition, digitalis is an uncertain diuretic where the heart is not affected, the drug is contra-indicated, especially in cases of chronic tubal nephritis uncomplicated by cardiac disease. Still another reason why it should not be employed is the fact that it retards the elimination of urea and the chlorides. In many cases of granular, contracted, or cirrhotic kidney, however, where the cardiac hypertrophy induced has not succeeded in overcoming the peripheral resistance (and in consequence there has occurred dilatation of the left ventricle and of the mitral orifice, with resulting regurgitation), digitalis, acting in the same manner as in cases of mitral regurgitation without renal disease, renders efficient service. In this condition the well-known diuretic pill consisting of calomel, digitalis, and squill, .06 gm. (1 gr.) each, made up with extract of hyoscyamus, may be used.

Exophthalmic Goitre.—It has been used to a considerable extent in this affection, but has proved an uncertain remedy. Even after a long course of it, the condition often remains unimproved. Still, it would seem to be worth trying, as it is said sometimes to be remarkably successful in controlling the symptoms. It may be combined advantageously with iron, ergot and zinc bromide. Even in incurable cases the cardiac irregularities and the dilatation of the cervical vessels are sometimes ameliorated, while cases purely functional in character, in young subjects, have been reported to be cured by digitalis.

Bronchitis and Pneumonia.—In chronic bronchitis with profuse secretion it has been found of more or less service in diminishing the secretion and pulmonary congestion, and consequently the dyspnœa, sweating and progressive loss of strength caused by them. It is also sometimes serviceable in chronic bronchitis with interstitial pneumonia (fibroid lung), when accompanied with dyspnœa, secondary dilatation of the right heart, and general anasarca. Here, in cases in which its action is satisfactory, it lessens the cough and expectoration, tones up the weakened and laboring heart, and reduces the œdema. In the second stage of acute pneumonia, in cases where the heart, with almost empty arteries, is laboring and unable to do its work properly, it has proved of very great value. In any form of pneumonia (whether adynamic or not) when the right heart is becoming unable to force the blood through pulmonic capillaries which are compressed by the existing exudation, digitalis may be found extremely useful. In the bronchitis and bronchopneumonia of children it may also prove beneficial.

Scarlet Fever.—Some authorities recommend digitalis highly in this disease, in which it is claimed that it reduces the temperature and maintains the action of the kidneys; thus diminishing the two principal sources of danger. From a teaspoonful (4 c.c.) to a tablespoonful (16 c.c.)—according to the patient's age—of the infusion may be given every two, three or four hours.

In various adynamic fevers digitalis is sometimes of the greatest value in sustaining the heart's action during a crisis or period of special strain upon the organ.

Alcoholism.—In chronic alcoholism digitalis, in moderate doses, may prove of service, on account of the stimulating effect of the agent on the circulation. As to its value in delirium tremens authorities differ. While some maintain that it is practically useless, others assert that excellent results may be obtained from it, especially in cases where the pulse is very weak and compressible. The rest and sleep which, it is claimed, follow its administration are believed to be due to the cardiac stimulation and increased flow of blood to the nerve-centres caused by it. While enormous doses of the drug—15, c.c. (½ fl. oz.) of the tincture being the usual dose—are generally tolerated in these cases, probably because by long habit the heart has become benumbed to the influence of stimulants, their use is not altogether unattended with danger. Some who believe in the efficacy of digitalis in this condition regard these large doses as unnecessary, and also hold that the infusion is preferable to the tincture. Of the infusion it is advised that 16 c.c., or one tablespoonful, be given every four hours. Digitalis is sometimes given in the young and robust, with marked cerebral hyperæmia, but it is probably more efficacious in pale subjects with a tendency to cyanosis, in whom there is cerebral anæmia, with effusion and œdema. As has been mentioned, there is a remarkable tolerance for digitalis in this condition, but since the use of the drug is occasionally followed by fatal results, it would seem to be the part of prudence to carefully select the cases in which it is employed and to avoid excessive doses.

Spermatorrhœa.—Digitalis has decided value as an anaphrodisiac. It has been found that it is capable of temporarily but completely annulling the activity of the sexual organs, and it is therefore of service in preventing erections of the penis due to local irritation, and also nocturnal seminal emissions and other effects of genital excitement. It is adapted to cases of spermatorrhœa in which there is an atonic condition, shown by feeble erections, frequent emissions, and cold hands and feet (where it may advantageously be combined with ergot), and also to the spermatorrhœa of plethora. In the latter it is claimed that better results can be obtained from digitalis in combination with potassium bromide than from any other treatment. In this condition 15 c.c. (½ fl. oz.) of infusion of digitalis, with 1.20 gm. (20 gr.) of potassium bromide may be given night and morning for a week, and after that at night only.

Hæmorrhage.—Digitalis is occasionally prescribed as a hæmostatic, but is unreliable because the increased blood-pressure to which it gives rise may excite still greater hæmorrhage. While it causes constriction of the vessels, it also accelerates the flow of blood through them. It may sometimes prove useful, however, in hæmorrhage from a large surface, as in the hæmorrhagic diathesis and in pulmonary hæmorrhage. It has been found of advantage in cases of hæmorrhage in the first stage of pneumonia and in hæmoptysis due to disease of the mitral valve.

Uterus.—If, as seems to be the case, digitalis has the power of inducing uterine contractions, it would naturally be expected that it would be of service in hæmorrhages of that organ. In practice it has been found in cases of menorrhagia that shortly after a large dose of the infusion has been taken severe pains resembling those of labor come on. There is a momentary profuse discharge of blood and clots, if the latter be present, and this is followed by arrest of the flow for hours. The drug is stated to be particularly advantageous in menorrhagia or metrorrhagia occurring in plethoric individuals and in cases where the hæmorrhage is dependent upon mitral disease. Both mitral regurgitation and stenosis, by increasing the blood-pressure in the uterine veins, sometimes give rise to menorrhagia of a peculiarly obstinate kind. Digitalis has also been used successfully to arrest *post-partum* hæmorrhage, but is much inferior to ergot in this regard.

Antagonists.—Reference has already been incidentally made to the antagonism between digitalis and aconite and other drugs. Aconite, while it also slows the heart, does so by dilating the peripheral vessels and lowering the blood-pressure, and is a cardiac poison; directly lowering the action of the cardiac motor ganglia and thus weakening instead of strengthening the pulsation. Aconite acts quickly and digitalis very slowly, and this interferes to some extent with the efficacy of the latter in poisoning by the former. Opium, aconite, muscarine, lobelia, the nitrites, and other agents antagonize some of the actions of digitalis, but the antagonism does not extend throughout the whole range of their effects. Saponin and senegin, to which it is closely allied, are considered to be most complete physiological antagonists to digitalis. Tannin is the chemical antidote.

STROPHANTHUS.

1. **STROPHANTHUS.**—Strophanthus. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparation.

Tinctura Strophanthi.—Tincture of Strophanthus. **Dose, 0. 5 c.c. (8 ♏).**

2. **STROPHANTHINUM.**—Strophanthin. **Dose, 0.0003 gm. = 0.3 milligm. ($\frac{1}{200}$ gr.).**

ACTION OF STROPHANTHUS.

External.—It has no action on the skin, but causes marked irritation of mucous membranes. Locally strophanthin is an anæsthetic, rapid in action and durable in effect, but so irritating that its application to the eye, for instance, is liable to set up inflammation or even ulceration.

Internal. *Gastro-intestinal Tract.*—In small doses it promotes appetite and digestion, and in larger ones it does not ordinarily cause gastro-intestinal derangement. It is true that, as in the case of digitalis, vomiting and diarrhœa are sometimes occasioned by strophanthus, but it will generally be found that these disturbances result from preparations from which the fixed oil contained in the seeds has not been extracted. The tincture, prepared from strophanthus kombé (pubescent variety), does not give rise to them; while fluidextracts made from this and other species cause digestive disturbances varying from simple inappetence, nausea and vomiting to abdominal pain and diarrhœa. Strophanthin, used hypodermatically, is not irritating to the digestive tract.

Muscles.—Strophanthus is essentially a **muscle poison**, as shown in experiments upon the frog with the African kombé arrow poison, which is made from the plant. Its first effect is to increase the tonicity of the muscular fibre, and when the muscle dies it does not go into relaxation, but passes directly from life into post-mortem rigidity. It occasions stiffness of the limbs and afterward complete loss of voluntary movement. Its influence is more generalized than that of digitalis, which, while acting on all the muscular tissue, has a more special action on the heart and the muscle of the arterial wall. The physiological as well as the toxic action of strophanthus are mainly exerted on both the heart and the voluntary muscles, so that when full effects are produced on the cardiac muscle the general muscular system is decidedly affected. In toxic doses it paralyzes muscular tissue, not through the nervous system, but by **direct contact**, and when contractility has once been destroyed by its action, no stimulus will reëxcite it.

Heart.—Strophanthus being believed to exert its action upon muscular tissue by direct contact through the blood, and the heart naturally receiving a much larger supply of blood in the same length of time than any other muscle, that organ is promptly and decidedly influenced by the drug. By proper regulation of the amount administered the heart may be acted upon while the muscles in general remain practically unaffected. In moderate doses strophanthus has the **same effect** on the heart **as digitalis**, stimulating the tonic contraction of the cardiac muscle, increasing the force of the ventricular systole, prolonging the diastole, lowering and regulating the rhythm, and causing a pronounced though slow rise in the arterial pressure by the increased force in the cardiac contractions. While some authorities deny that it acts on the pneumogastric like digitalis, and others assert that it has a similar influence on the inhibitory mechanism, there can be no question that it does have the effect of slowing the rate of the beat. Apparently this is a result of its direct cardiac action. If it has any influence at all upon the innervation of the heart, this would seem to be but temporary. In large amounts the drug paralyzes the heart, leaving its muscle completely rigid for the reason given above.

Vessels.—The latest researches show that strophanthus, through its characteristic action on all muscular tissue, including that in the arterial walls, has a decided influence upon the vaso-motor system; but the **constriction** of the peripheral vessels due to it is considerably **less marked** than that caused by digitalis. This is the most important point of difference between the two agents. Under the effect of digitalis, which powerfully contracts the vessels, and thus occasions a greater rise of blood-pressure than strophanthus, the work of the heart is much increased by the resulting resistance, and for this reason the latter is the safer remedy of the two.

Kidneys.—Strophanthus is an **efficient diuretic,** increasing the quantity of urine not only in cases of cardiac disease, but also in healthy men and animals, and this diuretic influence is apparently exerted not only through the increased force of the heart and the effect on the circulation caused by it, but also through direct action upon the secreting structure of the kidneys. The correctness of this view seems to have been confirmed by the renal lesions observed in poisoning by strophanthus and by oncometric experiments indicating that it produces no marked congestion of the kidneys.

Nervous System.—As has been stated, the pronounced effects which it has upon the heart and muscles are in all probability due solely to its direct action by contact, through the blood, and not through the agency of any influence it exerts upon the nervous system. On the latter, so far as known, it has no action.

Respiration.—Strophanthus appears to have no action on the respiratory centres. In experiments upon frogs it was found that the respiration continued for some length of time after the heart stopped, and the conclusion that the cessation of respiration was due to muscular influence was reached.

Temperature.—It is antipyretic within a limited range, because under its administration the consumption of oxygen is smaller and the processes of combustion are depressed.

Absorption and Elimination.—Since its active principle is soluble in less than its own weight of water, strophanthus possesses the diffusibility of a soluble crystalloid; hence the prompt results from its administration. Again, its active principle escapes with the urine, so that we also have ready elimination. This, however, is somewhat slower than its absorption, and there is, therefore, an overlapping of effect from too frequently repeated doses. Habit does not seem to impair the therapeutic usefulness of the drug.

THERAPEUTICS OF STROPHANTHUS.

Having the same general effects, strophanthus is employed to fulfil the same indications as digitalis. On the heart it acts more promptly, though probably less permanently than the latter. As the indication is generally as much to diminish the resistance to the heart as to increase the amount of work which the organ is capable of doing, strophanthus has the great advantage over digitalis of not greatly constricting the arterioles. If, therefore, the heart is feeble and the arterial tension high, strophanthus is decidedly to be preferred, unless some agent, like nitroglycerin, which has the effect of causing dilatation of the peripheral vessels should be given in connection with the digitalis. In those cases where digitalis does harm by so overstimulating the ventricle that the auricle cannot thoroughly empty itself, and hence becomes congested, strophanthus is sometimes of the greatest service. Where extensive degeneration of the arterial coats is present, so that the increased pressure in the interior of the vessels may lead to rupture of their walls, strophanthus, as causing a less extensive rise in the blood-pressure than digitalis, should be employed if the administration of a cardiac stimulant is called for. Its superiority as a diuretic renders it particularly valuable in œdema of the lungs or cases of general cardiac dropsy. It is often given advantageously in combination with digitalis, especially where free diuresis is desired, and is also much relied upon to take the place of the latter where its administration has to be suspended either on account of gastric irritation or for the prevention of cumulative effects. It is of great value in the cardiac diseases of children, in which digitalis is very apt to fail, and excellent results may also be obtained with it in corpulent individuals. Of especial importance should be considered its administration for the weak hearts of anæmia and chlorosis, in order that nutrition may be improved; for so-called irritable hearts, where the pain and palpitation are relieved; for debilitated hearts, associated with dyspeptic symptoms, and particularly flatulence (which usually disappears); and in the aged when there is vertigo as the result of cerebral anæmia. It is also said to be particularly useful in the progressive heart-failure of elderly patients, with attacks of dyspnœa simulating angina. The advantages which strophanthus possesses over digitalis may be summoned up as (1) greater rapidity, modifying the pulse-rate within an hour; (2) less marked vaso-constrictor effects; (3) greater diuretic powers; (4) no disturbance of digestion from properly made preparations; (5) absence of so-called cumulation; (6) greater value in children; and (7) greater safety in the aged.

The therapeutic indications for the use of strophanthus are, then: (1) Rapidly recurring cardiac systoles of lessened force and irregular rhythm. We get, first, a more vigorous contraction of the ventricle, with a slowing of the pulse-rate and consequently a lengthening of the diastole, which is the period of rest for the heart; next comes the disappearance of irregularity of rhythm; and, lastly, from improved intracardiac nutrition, a permanent strengthening of the heart-muscle. (2) The comparative insignificance of its vaso-motor effects enables us to use this remedy in those instances of permanent high tension which are met with in some forms of Bright's disease, in arteriosclerosis, and in the rigid arteries of the aged. (3) Whenever diuresis can be promoted by increased blood-tension resulting from more vigorous cardiac contractions this may be expected from the use of this remedy. (4) The rapidly appearing effects of its administration, together with its regular elimination, make it the drug of choice when the symptoms are urgent. (5) The absence of digestive disturbances from therapeutic doses and slight likelihood of habituation to its administration make it important when long-continued use is necessary. It should, therefore, be the remedy of choice in all cases, (1) in which we wish to establish compensation; (2) of arterial degeneration in which a remedy which causes more energetic cardiac contraction is required; (3) of cardiac disease when a diuretic is necessary; (4) of weak or irritable hearts; (5) of cardiac disease in childhood or old age.

The instances in which failure will follow its administration are those of (1) advanced degeneration of the myocardium; (2) extreme mechanical obstruction to the circulation from valvular incompetency or obstruction; and (3) a combination of these. It will readily be understood that in fully compensated hearts this—as well as other drugs of the same type—is unnecessary, and when over-compensation exists it will likely aggravate the condition. It may be said, therefore, that success in the administration of strophanthus requires: 1. An active, well-made preparation from a reliable source. 2. Avoidance of its use in fully or over-compensated hearts and in those which present advanced muscular degeneration or mechanical defects of high degree. 3. The use of not too large or too frequently repeated doses. Careful observation has shown that the dose of 0.30 c.c. (5 ♏) of a reliable tincture three or, possibly, four times a day is sufficient.

Strophanthus has been found of service in exophthalmic goitre, and, administered in combination with hoang-nan, it has also given good results in psoriasis, especially in cases attended with marked congestion of the integument.

ADONIDIN.

Adonidinum.—Adonidin (not official). **Dose, 0.01 to 0.02 gm.; 1/6 to 1/3 gr.**

ACTION OF ADONIDIN.

Adonidin has the **same** physiological **action** as **digitalis**, and produces its effects more promptly than the latter. In the frog it causes tonic contraction of the heart and slows the pulse-rate. It increases the force of the systole, and finally produces arrest. In mammals it slows and strengthens the heart's action, and whilst diminishing the pulse-rate, very markedly increases the arterial pressure. It raises the general vascular tension by causing constriction of the arterioles, but the contraction is not so persistent as under the use of digitalis. The slowing of the rate is no doubt due to stimulation of the inhibitory nerves, since it is prevented by their previous section, while the rise in arterial pressure is chiefly attributable to the direct action of the drug on the heart. Under the continuance of full doses the primary rise is followed by a marked depression, and this late fall is believed to be the result, at least in great part, of vaso-motor paralysis. In toxic doses it is found to paralyze the terminals of the pneumogastric, excite the accelerator apparatus of the heart, and finally cause paralysis of the cardiac motor nerves. Adonidin renders the respiratory movements more full and less frequent. It also probably increases the flow of urine, its diuretic action being due to its effect on the circulation rather than to any direct influence on the secreting structure of the kidneys. In many subjects it seems to cause more or less nausea, vomiting and purging. It is rapidly eliminated from the system, and therefore does not appear to have any cumulative tendency.

THERAPEUTICS OF ADONIDIN.

It is used for the same kinds of cases as digitalis. It has been found less certainly beneficial than the latter in valvular disease of the heart, but may prove a satisfactory substitute for it in cases in which that drug fails or is not well borne. As its action is more prompt, adonidin sometimes serves a useful purpose in beginning the regulation of the cardiac movements before digitalis has had time to produce its effect. In addition to cases of organic disease, it has been found of service in functional irregularity, and especially in palpitation without any lesion of the heart. In combination with the bromides it is also said to be used with success in the treatment of epilepsy. The irritating properties of this drug prevent its subcutaneous use, and even prolonged administration by the mouth.

SQUILL.

SCILLA.—Squill. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Preparations.

1. **Acetum Scillæ.**—Vinegar of Squill. **Dose, 1 cc. (15 ♏).**
2. **Fluidextractum Scillæ.**—Fluidextract of Squill. **Dose, 0.1 c.c. (1½ ♏).**

3. **Syrupus Scillæ.**—Syrup of Squill. **Dose, 2 c.c. (30 ♏).**

4. **Syrupus Scillæ Compositus.**—Compound Syrup of Squill. (Hive Syrup.) **Dose, 2 c.c. (30 ♏).**

5. **Tinctura Scillæ.**—Tincture of Squill. **Dose, 1 c.c. (15 ♏).**

Action of Squill.

The application of squill to the external integument is capable of producing the characteristic effects of the drug on the system. It affects the heart and arterial system in the **same manner as digitalis,** but its action on the heart, and especially on the peripheral vessels, is less marked and decidedly less persistent than that of digitalis. The increased arterial pressure caused by it is due, it is believed, partly to the augmented cardiac force and partly to a peripherally produced vaso-motor contraction. It is a much more violent **gastro-intestinal irritant** than digitalis; causing, in sufficient doses, marked abdominal pain, vomiting, purging, and even fatal gastro-enteritis. Even small doses are liable to cause nausea. Another pronounced action of squill is that of an **expectorant,** and this, like its effect to a great extent on the gastro-intestinal tract, is probably produced during excretion. In passing through the bronchial mucous membrane it sets up an irritation which stimulates the blood-vessels of the part, and thus increases the functional activity of the membrane. In addition to these actions, it is an efficient **diuretic,** promoting the activity of the renal circulation, and largely increasing the watery portion of the urine. It is stimulating to the kidneys, and in excessive doses gives rise to such an amount of irritation as to cause strangury and diminished secretion, the urine often being bloody and albuminous. The renal inflammation may even be so violent as to result in complete suppression.

Therapeutics of Squill.

Squill has been called the "harsh digitalis." In cardiac disease, with or without dropsy, it is not prescribed alone, as digitalis, strophanthus and other heart stimulants are more efficient, as well as less toxic, in their effects. It may, however, be combined with digitalis with advantage, especially in dropsical cases, and a very favorite diuretic pill is composed of squill, digitalis and calomel, .06 gm. (1 gr.) each, made up with extract of hyoscyamus, .09 gm. (1½ gr.). This is sometimes known as Guy's triplex pill. Squill was formerly much in vogue in the treatment of renal dropsy, but is now rarely or never employed in cases of this kind, on account of its irritating effect upon the kidneys. It is valuable in dropsy not dependent on renal disease when the system is in an atonic condition, and it has been found of service, especially in combination with calomel, in serous effusion into the pleura and the pericardium resulting from chronic inflammation of the parts. When the stomach is intolerant of the drug, it may be administered by rubbing its tincture, with that of digitalis, into the skin, or by applying compresses saturated with these to the abdomen, and covering them with an impermeable dressing. Squill is principally used, however, in subacute and chronic bronchitis and emphysema, and, given in suitable doses and in connection with other appropriate drugs, is a most valuable remedy. It is more particularly indicated when the sputa are tenacious and coughed up with difficulty, and it is therefore desirable to employ with it an agent which increases the expiratory force. As a stimulating expectorant, it is especially useful in the second stage of bronchitis, when secretion is scanty or so excessive as to need proper stimulation of the mucous membrane to bring on a healthy action. It should not be given in cases of phthisis or other chronic disease where there is any gastric irritation. Neither the syrup nor the vinegar of squill should be prescribed with ammonium carbonate, as the latter is incompatible with acetic acid, which is contained in both these preparations.

CONVALLARIA.

CONVALLARIA.—Convallaria. (Lily of the Valley.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Fluidextractum Convallariæ.—Fluidextract of Convallaria. **Dose, 0.5 c.c. (8 ♏).**

ACTION OF CONVALLARIA.

In moderate doses convallaria has been found to at first slow the heart and raise the arterial tension, while subsequently the pulse is somewhat quickened. Section of the pneumogastric does not interfere with these actions. At the same time that the heart is thus affected, respiration is deepened and to some extent slowed. It is a decided cathartic, increasing peristalsis and having an action on the bowels intermediate between those of scammony and aloes. It also acts to some extent on the kidneys. Under toxic doses the respiratory movements become very full and slow, the reflex function of the cord is abolished, and the heart is paralyzed. Death is caused by the direct action of the drug on the heart. It appears to have no cumulative action.

THERAPEUTICS OF CONVALLARIA.

Convallaria has been used extensively in the same range of cases as digitalis. It is said to act more powerfully upon the right heart than the latter, but this is probably not true. The reports of the results of its employment in cardiac disease, however, have been by no means uniformly favorable, and a more extended experience seems to indicate that this drug is very unreliable. It is, however, free from most of the undesirable effects of digitalis, to which reference has been made, and in dropsical cases especially it has sometimes proved of service. Some writers assert that it is particularly useful in cases of arhythmia and "cardiac hurry." At the present time convallaria is employed very little.

CAFFEINE.

CAFFEINA.—Caffeine. (Theine. Guaranine.) **Dose,** 0.065 gm. = 65 milligm. (1 gr.).

Preparations.

1. **Caffeina Citrata.**—Citrated Caffeine. **Dose,** 0.125 gm. = 125 milligm. (2 gr.).

2. **Caffeina Citrata Effervescens.**—Effervescent Citrated Caffeine. **Dose,** 4 gm. (60 gr.).

Unofficial Preparations.

Caffeinæ Sodio-Benzoas.—Caffeine Sodium Benzoate. **Dose, 0.125 to 0.60 gm.; 2 to 10 gr.**

Caffeinæ Sodio-Salicylas. — Caffeine Sodium Salicylate **Dose, 0.125 to 0.60 gm.; 2 to 10 gr.**

ACTION OF CAFFEINE.

External.—Roasted coffee, especially in the form of powder, appears to have some disinfecting and deodorizing power.

Internal. *Alimentary Canal.*—Coffee in small amounts is a stomachic tonic, and generally has a somewhat laxative effect; increasing (probably by reason of its volatile oils) the peristaltic movements of the intestine. The so-called biliousness sometimes caused by its habitual use is probably occasioned by the empyreumatic oil, caffeol or caffeone, which is one of its constituents and which, if taken alone, is likely to disorder the digestion. The excessive use of both tea and coffee is liable to give rise to indigestion, acidity and heart-burn. Such use of tea is more prone than that of coffee to produce injurious effects in the alimentary canal, as well as elsewhere, partly perhaps because, as a rule, more of the former than of the latter is consumed, and also because the effects of the continued action of the tannin in the tea are no doubt even more deleterious than those of caffeine. They not infrequently induce chronic constipation and cause very serious interference with digestion. The teeth of tea-tasters are very liable to decay.

Heart.—From recent experiments on the dog's heart the effect of caffeine appears to consist in (1) an acceleration of the rhythm without further change; (2) a shortening of the movements, commencing in the auricle and spreading to the ventricle; and, in large doses, (3) auriculo-ventricular arhythmia, terminating in fibrillary contractions of the auricle, and finally of the ventricle. The primary acceleration would seem to be due to stimulation of the most irritable part of the heart, the so-called excito-motor apparatus, and as no further change in the movements is seen, the action of the drug at this stage appears to be confined to this area. The second change may be due in part to the acceleration, and thus be considered a secondary effect of the increased irritability of the excito-motor area; but it may also be ascribed, it is thought, to the action of the caffeine on the muscle of the auricle and ventricle, and may thus indicate that the influence of the drug has extended to these less susceptible parts of the heart. The third stage, that of arhythmia, is believed to be due to the ventricular irritability having been so greatly increased as to give rise to an idioventricular rhythm. The interference of the two rhythms, then, explains the major part of the variation in the strength of systole and the extent of diastole. The idioventricular rhythm indicates that the characteristic stimulant action on the cardiac muscle has extended to the ventricle. When this has attained a sufficient height it leads to fibrillary contractions in the ventricle; the previous appearance of these in the auricle appearing to indicate that the stimulant influence spreads to this before it reaches the ventricle. The action of caffeine on the mammalian heart thus appears to consist in a **descending stimulation,** which begins in the excito-motor area at the junction of the auricle and great veins, and extends into the auricles and finally to the ventricles. The effects can be explained by direct action on the muscle, without the necessity of appealing to any nervous apparatus, and these experiments do not support the idea that the nervous apparatus of the heart is involved in the effects. Comparing the action of caffeine on the dog's heart with that of digitalis, it is found that, as far as the direct action on the heart is concerned, they resemble each other in both affecting only the heart muscle. But while in the case of digitalis the earliest changes seen are in the strength of systole and extent of diastole in the ventricle and auricle, the stimulation exercised by caffeine begins in the excito-motor area and descends to the auricle and then to the ventricle, and its effects on the rhythm (as far as these are caused by direct action on the heart) are of secondary importance. Furthermore, the primary changes induced by digitalis are not so much evidenced by increased irritability of the parts affected as by increased contractibility and lessened dilatation (increased tone), while there is no evidence of such a change in the late stages of caffeine poisoning, in which the ventricle is directly affected.

Vessels.—Caffeine **stimulates the vaso-motor centre,** and under its influence the blood-vessels are therefore contracted, causing a **marked rise** in the **arterial pressure.** The muscle-fibre in the walls of the vessels, in common with the muscles in general, is also acted upon by the drug. Under small doses the constriction of the arteries, which is of comparatively short duration, is followed by an expansion of much longer duration, but with larger doses the subsequent dilatation does not occur. After repeated intravenous injections caffeine is found to fail to produce vascular dilatation, and soon each injection is followed only by vascular constriction. It has been demonstrated that the vaso-constriction caused by the drug is principally the result of central stimulation by the fact that this effect is very largely interfered with by chloral, which paralyzes the vaso-motor centre. That the rise of pressure is not due to increased cardiac energy is shown by its absence in preparations of the isolated mammalian heart.

Muscles.—Small doses increase the excitability of the muscles, augmenting the quickness and force of their contraction. Under larger doses the height of the contraction of the muscle is less, the maximum load it is capable of lifting is smaller, and the muscle is exhausted by tetanus more quickly than a normal muscle. The contraction then becomes smaller and smaller, and the muscle gradually passes into rigor. In mammals much larger quantities of the drug are required to induce rigor than to paralyze the respiration.

Respiration.—Respiration is quickened and strengthened by caffeine, which has a **stimulating** effect upon the **respiratory centre** in the medulla. This effect is shown in the improvement in the respiration caused by it in cases of poisoning by alcohol, opium and other drugs, but it is much less marked in the normal condition of the system. In toxic doses it produces first quickening and then paralysis of the medullary centre.

Nervous System.—Caffeine is a **rapidly-acting stimulant** to the cerebrum, medulla oblongata, and spinal cord. In its effect upon the cerebral centres the blood-supply would seem to bear an important part; it being probable that the circulation in the brain is affected indirectly by the changes produced in the general circulation. Any agent which causes general arterial constriction will tend to passively induce dilatation of the cerebral vessels, and hence it may be supposed that such dilatation accompanies the general vaso-constriction due to the exhibition of caffeine. In the cerebrum the drug affects the psychic functions, and is without doubt the most certain and effective stimulant that we have to the nerve centres connected with the intellectual faculties. Consciousness is enjoyed to the fullest extent, all drowsiness is banished, and the highest mental powers have full play. The cerebral stimulation caused by it differs from that due to opium in that the reasoning faculty is not less affected than the imagination and in that the excitation is not incoördinate. Caffeine acts on the same parts as are first affected by alcohol and other agents of its class; but alters them in the opposite direction. They are the centres which are also first paralyzed, to some degree at least, by morphine and cannabis indica. Caffeine is therefore an efficient antidote for these, and especially for alcohol, since the medullary and spinal effects are also antagonistic. The sleeplessness often caused by tea and coffee is probably due in part to stimulation of the nerve centres and partly to the indirect effect of the dilatation of the cerebral blood-vessels caused by the constriction of the vessels of the body generally. In addition to tea and coffee, cocoa, coca, kola, guarana and the various other substances which have long been in use as beverages in different parts of the world all contain either caffeine or analogous alkaloids. They impart a sense of grateful refreshment, relieve fatigue, mental and muscular, and increase the capacity for physical exertion and endurance. The effect of caffeine on the acuteness of the senses is shown by the greater accuracy of touch under its influence. While the results of the drug taken in moderate quantity are of distinct benefit in intellectual work, larger amounts are apt to render connected thought more difficult, as impressions follow each other so rapidly that the attention becomes distracted. These larger doses often over-stimulate the cerebral circulation, causing pain and a sense of fullness in the head, restlessness and insomnia, with more or less confusion of mind, or even hallucinations and delirium. Sometimes tinnitus aurium and flashes of light before the eyes indicate derangement of the special senses. The pulse becomes rapid and irregular, and cardiac uneasiness or palpitation may occur; while in some instances convulsive movements of the hand and tremor in different parts of the body are noted. It is stated that such effects as these are induced only with difficulty in habitual tea or coffee drinkers; so that the continued use of small quantities of caffeine would seem to give rise to tolerance. Toxic doses, administered to animals, occasion rise of temperature, convulsions and general paralysis, but the temperature declines when paralysis supervenes. In the medulla, while caffeine has a marked stimulant effect on the activity of the vaso-motor and respiratory centres, it exerts practically no action on the vagus centre. In the spinal cord it excites reflex activity. It causes convulsions in the frog, and that these are not of cerebral origin is shown by the fact that section of the upper cord does not prevent them. On the other hand, destruction of the cord does have the effect of preventing them, so that they are no doubt spinal. The effects of caffeine on the cord are reflex irritability, then tremors, and finally tetanus. They closely resemble those of strychnine, but are very much smaller, and occur only with relatively larger doses. This tetanus, which, like that of strychnine, is located in the cord, shows the same intermittent character and also involves the respiratory muscles in the same manner. It occurs both in mammals and frogs, but the dose required for the former is considerably larger than that necessary to give a vaso-motor, cardiac or diuretic effect. The motor nerves appear not to be affected by caffeine, but the sensory nerves are apparently slightly influenced by it.

Kidneys.—Caffeine, in small doses, usually has a marked effect in **increasing diuresis.** It is a matter of common observation that both tea and coffee augment the flow of urine to a much greater extent than the same amount of water, and this has been shown to be due to the caffeine which they contain. It was formerly supposed that the diuretic influence of this agent was principally owing, as in the case of digitalis, to an increase of cardiac energy which improved the renal circulation, but this is now known not to be so, since it has been shown that when changes in the circulation are prevented from taking place the same increased flow of urine occurs under its influence. While the vascular expansion following the primary constriction of the vessels caused by small doses of the drug no doubt assists in the promotion of diuresis, the latter is mainly due to the direct action which it has in stimulating the renal epithelium. The increased activity of the secretory cells occasioned by it is also accompanied by a slight dilatation of the vessels of the part which is analogous to the vascular dilatation in a muscle undergoing contraction. But this tendency to produce a dilatation of the renal vessels is always liable to be counteracted by the pronounced action of the caffeine on the vasomotor centre, which, on the other hand, tends to constrict the vessels. Such constriction has the effect of diminishing, and many even inhibit, the secretion of urine. Sometimes, therefore, it is found that the administration of caffeine not only produces no diuresis, but has the directly contrary effect; for if the contraction of the arterioles caused by it is great enough, the epithelial cells, however active they may be, can, owing to the interference with their blood-supply, secrete but little. Consequently, it will be seen that caffeine is by no means a certain diuretic, and in cases where it thus fails measures must be taken which will prevent its action on the central nervous system. Under the diuretic effects of caffeine both the solids and the fluids in the urine are increased, but the former to a less extent than the latter. It is said that the excretion of alkalies, and especially sodium, is augmented even out of proportion to the diuresis.

Metabolism.—The effect of caffeine upon tissue waste has been much investigated, with very contradictory results. According to some of the latest and best authorities it causes a slight rise of temperature, partly by its action on the central nervous system, and more particularly by its direct muscular effects. In consequence of this, it is claimed, it also increases the metabolism, that is, the production of urea and carbon-dioxide. If this view is correct, the older one that it lessens metabolism is consequently erroneous. Caffeine is excreted in the urine in small quantities, but a considerable proportion of it is probably decomposed, with the formation of xanthin, which is further broken up into urea.

THERAPEUTICS OF CAFFEINE.

Heart.—As caffeine cannot be administered subcutaneously alone, owing to its decomposition in the presence of water, it is necessary, for this purpose, to substitute for it the sodio-salicylate or benzoate. In cardiac disease caffeine has been employed to a considerable extent as a substitute for digitalis, but as has been seen, its action on the heart is different from that of the latter and cannot, therefore, take its place. As a rapidly-acting cardiac stimulant it may prove of service in a variety of conditions, and in certain cases with feeble action of the heart it also does good by increasing the general blood-pressure, through its constricting influence on the arterioles, and thus producing a more efficient circulation. Its chief utility in heart affections, however, is in cases attended with dropsy, where by its marked diuretic action it proves highly efficacious in a considerable proportion of instances. It may often be combined with advantage with digitalis, strophanthus, or other drugs having a similar cardiac action. The preparations of caffeine are useful also when combined with antipyrine or acetanilide derivatives to counteract their depressing influence upon the heart, as in the official compound acetanilide powder. Caffeine sometimes causes so much insomnia that its use has to be discontinued, and it is alleged that occasionally it sets up considerable smarting in the penis and even a mild form of urethritis. The nervous phenomena and the irregularity of the heart's action sometimes occasioned by tea and coffee are generally recognized.

Kidney.—The physiological action of the drug shows it to be within certain limitations a diuretic of great value. It is a fact worthy of note and to be borne carefully in mind in the therapeutic use of caffeine, that the diuresis is produced by smaller doses than those required for any other of its effects. This constitutes a point of great practical importance, for the smaller doses, while sufficient to bring about the desired effect on the kidneys, do not as a rule affect the central nervous system to such an extent as to cause the antagonistic vaso-constriction which so seriously interferes with the renal function. Even when given in the smallest supposedly effective dose, however, its effect upon the urine is somewhat variable, and in order to secure satisfactory diuresis it is therefore sometimes advisable to administer with it some such agent as hydrated chloral, which diminishes the excitability of the medullary centres. It should seldom or never be employed in acute inflammatory conditions of the kidney, because stimulants are contra-indicated when the part they influence is inflamed; but it is sometimes of service in chronic Bright's disease, especially when there is marked cardiac failure. When, however, the secreting cells are in such a state as to be incapable of stimulation, it will naturally prove inefficient; so that in renal dropsy it may be said to be useful in inverse ratio to the amount of damage suffered by the kidneys. In simple cardiac dropsy, where it often acts so effectively, the epithelial structures are not diseased, but only passively congested. As a diuretic, caffeine is now regarded as decidedly inferior to theobromine, and the reasons alleged for this are: (1) because the diuresis is less certain and often accompanied by nervous symptoms such as restlessness and insomnia, and (2) because the secretion is smaller and lasts for a shorter time. Theobromine, while having an action similar to that of caffeine, has a much less pronounced effect upon the central nervous system.

Nervous System.—As a stimulant to the central nervous system, and especially to the respiratory centres, caffeine is of great service in cases of poisoning by opium and by alcohol. In the treatment of the former strong black coffee has long been in use, and caffeine might perhaps be substituted for it with benefit. Hot coffee, however, has the advantage of adding to the heat of the body, which is apt to be quite cold. It has been ascertained by experiment that within narrow limits there is a direct physiological antagonism between caffeine and morphine. In the insomnia of chronic alcoholism caffeine, in small doses given subcutaneously, has also been found useful. On the other hand, it is sometimes taken, in larger quantity, to produce wakefulness and increase the vigor of the mental powers during excessive use. So, in despondency and hypochondriasis and in neurasthenia it sometimes has a good effect. In migraine and other forms of nervous headache, such as hemicrania, with or without gastric derangement, it is much used. In this class of affections it is not so efficient as antipyrine; but it may often be advantageously combined with the latter, and, in addition, sometimes with one of the bromides. Some observers have also found it especially efficient when given in connection with acetphenetidin. If the headache is due, as is often the case, to errors of refraction, much benefit can hardly be expected from it. In trigeminal, cervico-brachial, and other neuralgias, particularly when given in combination with some of the coal-tar products, it often affords relief. In the adynamia of typhoid and other acute fevers it may at times prove useful, either alone or as an adjuvant to alcoholic and other stimulants. In some forms of malarial fever it is claimed that strong coffee has a curative effect. One reason that caffeine, as sold in the markets, so frequently gives rise to the peculiar nervous and renal by-effects that it does is because theine made from the sweepings of the tea-houses is substituted for caffeine.

Alimentary Tract.—Caffeine is a stomachic tonic, improving the appetite and digestion, and it has been found of service in convalescence from various acute diseases. In nervous dyspepsias and in chronic catarrh of the stomach with occasional attacks of migraine it is often useful. So also in the diarrhœa of phthisis and of typhoid fever, and in ordinary atonic diarrhœa, as well as in cholera infantum and in cholera morbus, especially when dependent on agencies affecting the nervous system. In affections of this character the sodium benzoate or the sodium salicylate, in combination with nux vomica or strychnine, may sometimes be used with advantage.

Respiration.—In certain cases of asthma it is of value; the paroxysm being promptly relieved by it. In many instances, however, it has little or no beneficial effect. In pneumonia or in congestion of the lungs, with weak heart, in elderly individuals, it sometimes proves of material service.

Uterus.—Caffeine sodio-benzoate has been recommended in puerperal hæmorrhage, the statement being made that when given subcutaneously it acts more promptly than ergot.

GUARANA.

GUARANA.—Guarana. **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Guaranæ.—Fluidextract of Guarana. **Dose, 2 c.c. (30 ♏).**

ACTION OF GUARANA.

Guarana is habitually used as a beverage by the South American Indians who make it. Its effects on the system are mainly those of its alkaloid, although it contains sufficient tannic acid to have an appreciable influence.

THERAPEUTICS OF GUARANA.

In medicine guarana is employed almost exclusively for the relief of headache. The forms of headache in which it is most serviceable are the nervous sick headache which recurs at short intervals, especially in women at the menstrual periods, and that which follows a debauch, when the head throbs and the eyes are bloodshot. In many instances, however, guarana, like most other remedies, gradually loses its power over such attacks, and may eventually aggravate them. In the headache of chlorosis guarana is said to be efficient in combination with cannabis indica. Almost the only other purpose for which the drug is now used is in the treatment of atonic chronic diarrhœa. By the Indians it is considered valuable in the prevention and cure of bowel complaints.

KOLA.

Cola.—Kola (not official). **Dose, 1.3 to 2.6 gm.; 20 to 40 gr.**

ACTION OF KOLA.

It is somewhat stimulating to the digestion and is like coca in enabling the body to undergo unusual exercise without fatigue. Its effects on the nervous system appear to be much the same as those of caffeine. Partly in consequence of its increasing the force and frequency of the pulse, the blood tension rises and metabolism is carried on more rapidly. As it contains a larger proportion of theobromine, it is said to have a more pronounced diuretic action than caffeine.

THERAPEUTICS OF KOLA.

It has been used in various phases of debility, including diarrhœas in the debilitated, in irregularity of the heart's action, as a vehicle for the administration of cardiac stimulants, in migraine, and in neuralgia and other nervous disorders. It is no doubt of most benefit in diseases characterized by great nervous weakness and in convalescence from acute diseases in which wasting is pronounced, of which typhoid fever is the type. It has a marked effect in relieving the mental depression, while the diminution of the natural tendency to faintness, the disappearance of nervous irritability, and the acquisition of the ability to undergo muscular exertion, under its use, are well established facts. When fatiguing literary work or monotonous mental application is called for, kola probably affords greater assistance than any other drug. It may be of service in those occasional instances of morbid somnolence which can be definitely stated to be not dependent upon dyspepsia in its various forms, diabetes, lithæmia, gout, nervous exhaustion, or malarial disease. It is also of value in the performance of muscular feats, from the caffeine which it contains in a nascent condition. It is highly prized by the natives of equatorial Africa, who take it to enable them to endure long exertion without fatigue, and use it as a masticatory. It is also reputed to render bad water palatable and tainted meat palatable. The most effective manner of employing the drug is said to be by slow mastication and swallowing the saliva.

ERYTHROPHLŒUM.

Erythrophlœum.—Sassy Bark (not official). (Ordeal Bark. Mancona Bark.)

Unofficial Preparation.

Tinctura Erythrophlœi.—Tincture of Erythrophlœum. **Dose, 0.30 to 0.60 c.c.; 5 to 10 ♏.**

Erythrophlœina.—Erythrophlœine (not official). **Dose, 0.0015 to 0.0020 gm.; $\frac{1}{40}$ to $\frac{1}{32}$ gr.**

ACTION OF ERYTHROPHLŒUM.

Under its influence the **heart** is at first **slowed;** later its action becomes rapid. The ventricles contract regularly and stop in systole, while the auricles may continue to beat. This slowing is remarkable (1) from the regularity and energy of the systoles, and (2) from the fact that during the slowing the uniform blood-pressure is not altered by respiratory movements. The **blood-pressure rises** because (1) of the increased energy of the heart and (2) of the contraction of the blood-vessels; this condition persists until the heart becomes irregular, when it falls. The **respiratory movements** are at first **slower** and **fuller,** but when the heart grows feeble they become accelerated, and during the period of weak and irregular cardiac action produce the so-called respiratory oscillations in blood-pressure. Moderate amounts **increase diuresis;** larger doses produce vomiting and increased peristalsis; poisonous doses induce convulsions, later, marked weakness of all muscles, and, finally, death. The mode of action may be summed up as that of a muscle-poison acting primarily upon the heart for the reason that the latter receives a larger quantity of poisoned blood. Still, its sphere of influence appears to be the inhibitory, rather than the muscular system, and upon the **vagus** its action resembles that of **digitalis.** It is a vaso-constrictor by acting on the vessels themselves, on the vaso-motor nerves, or on some vaso-motor centre not in the medulla, but probably in or around the vessels themselves. The respiration is influenced through the pulmonary branches of the vagus. Erythrophlœum is a **sternutatory** because the powdered bark is irritant to the nasal mucous membrane, it causes vomiting by reason of its solutions possessing the same property, and it is diuretic for the same reason and under the same conditions as digitalis. Its ability to slow the heart is rather greater than that of digitalis, but it is more decidedly a **gastric irritant.** Its vaso-constrictor properties are practically those of digitalis and ergot combined. It is rather less cumulative than digitalis; using this term in the same sense in which it is applied to the latter.

The alkaloid is **locally anæsthetic,** but although the anæsthetic condition induced by it lasts several hours, practically it is inferior to cocaine, since it dims the cornea and causes myosis, headache, giddiness and even syncope. Its employment for this purpose has therefore been abandoned.

THERAPEUTICS OF ERYTHROPHLŒUM.

The field of use for erythrophlœum would seem to be limited to the heart and blood-vessels in cardiac disease, whether accompanied by dropsy or not. The indications for its employment are identical with those for digitalis. As to constancy of effect in slowing the heart, strengthening the pulse, and promoting diuresis, digitalis is rather more reliable. The use of this remedy should, then, be confined to those cases of fairly competent heart with low vascular tension in which it will show its effects more rapidly and markedly, and to those cases in which digitalis has lost its usefulness or has utterly failed.

CAMPHOR.

1. **CAMPHORA.**—Camphor. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Preparations.

1. **Aqua Camphoræ.**—Camphor Water. **Dose, 8 c.c. (2 fl. dr.).**

2. **Ceratum Camphoræ.**—Camphor Cerate.

3. **Linimentum Camphoræ.**—Camphor Liniment. (Camphorated Oil.)

4. **Spiritus Camphoræ.**—Spirit of Camphor. **Dose, 1 c.c. (15 ♏).**

2. **CAMPHORA MONOBROMATA.** — Monobromated Camphor. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

3. **ACIDUM CAMPHORICUM.**—Camphoric Acid. **Dose, 1 gm. (15 gr.).**

ACTION OF CAMPHOR.

External.—Like the volatile oils, camphor acts as an irritant to the skin and mucous membranes. It is a direct cutaneous stimulant, causing **redness**, itching and **warmth**, owing to a local dilatation of the vessels. Later this sense of warmth is followed by some degree of **local anæsthesia** from paralysis of the sensory nerves. On mucous membrane it produces similar irritation, as indicated by congestion and smarting. It has some antiseptic action, but this is considerably weaker than that of some of the substances of the phenol group, and also of many of the volatile oils.

Internal. *Gastro-intestinal Tract.*—In small doses it is **stomachic** and **carminative,** inducing a feeling of warmth and comfort in the stomach. Here, as on the cutaneous surface, it causes dilatation of the vessels, and thus has a mildly **stimulating** effect on the secretion of gastric juice and on peristalsis. In larger amounts it may produce sufficient irritation to cause nausea and vomiting. In medicinal doses it has little action on the intestines themselves, but it exerts quite an efficient antiseptic influence in the bowel, as it is found that the amount of combined sulphates in the urine is diminished by it.

Absorption and Excretion.—Camphor is absorbed with considerable rapidity from the stomach and intestine, as well as from the skin and the respiratory mucous membrane when in contact with them. After absorption it is converted into camphorol, a body in which one atom of H in camphor is replaced by OH, and this combines with glycuronic acid and is excreted in part in the urine as camphor-glycuronic acid. An amido-derivative of this acid is formed at the same time, and is also found in the urine. Camphorol acts like camphor, but its glycuronic combinations are inert, so that the effects of camphor are observed to pass off quickly in such animals as the dog, in which these combinations are rapidly formed. In animals poisoned with camphor a considerable quantity of glucose is said to be frequently present in the urine.

Blood.—It is said to increase the number of leucocytes in the blood.

Heart and Circulation.—While the effects of camphor on the mammalian heart are as yet but very imperfectly known, it may be stated that the heart is generally **slowed** by the drug, while the **contractions** are at the same time greatly **strengthened.** This appears to be due rather to a direct stimulation of the cardiac muscle than to the influence of the regulating nerves. There may, however, be some slight reflex stimulation of the organ. On the normal heart camphor usually produces lengthening of the systole and shortening of the diastole, somewhat after the manner of digitalis, and the pulse becomes fuller, stronger and slower. The blood-pressure may either rise or show alternate rise and fall. Such variations are found to persist after convulsive movements have been prevented by curara, and it is therefore believed that the rise is mainly caused by a stimulation of the vaso-motor centre, and that this stimulation is intermittent in character, since the variations mentioned are independent of the respiration. The stimulation of the heart and the reflexes, especially those arising from the stomach, also, no doubt, contribute to the rise in blood-pressure.

Respiration.—The respiration is usually but slightly affected, but as a rule becomes slower and deeper under large doses. Some observers find the rate as well as the volume increased by it. During the convulsions caused by camphor in animals the respiration is arrested, and in the intervals may be accelerated in consequence of the muscular exertion during the spasms. Whether any excretion of the drug takes place by the lungs is not positively known, but the breath of persons using it sometimes smells of it, and it is thought probable that some camphor or some derivative from it is excreted by the bronchial mucous membrane, the vascularity and secretion of which is thus stimulated. It is generally regarded as an expectorant of somewhat feeble power.

Nervous System.—The action of camphor on the central nervous system in mammals has been found to consist in **stimulation**, followed by paralysis of the cerebral areas and probably of other intracranial centres, with less marked effect on the spinal cord. As regards the brain the stimulant symptoms begin in man with excitement, impulsive movements, confusion and delirium with hallucinations, and these are followed by **epileptiform convulsions.** In the lower animals the symptoms are similar: wild excitement and epileptiform convulsions, followed by depression, stupor and collapse. The convulsions have generally been attributed to stimulation of the medulla oblongata, but the epileptiform character of the attacks points to an affection of the cerebral cortex, and experimenters have found that removal of the cortex prevented the convulsions in mammals, though in the pigeon convulsions continued after the cerebrum had been removed. On the whole, there seems to be good reason for supposing that these seizures have their origin, at least partly, in the higher areas of the nervous axis. The first evidence of stimulation of the medulla is vertigo. Later all the medullary centres are stimulated: the respiration is increased in volume, the blood-pressure rises, and the face and skin become flushed in consequence of the stimulation of the vaso-dilator centre. Under sufficiently large doses the medulla is paralyzed, and collapse ensues, with death from failure of the respiration. Sometimes, however, the respiration ceases during a convulsion, and fails to return when it passes off. In man the epileptiform convulsions alternate with intervals of quiet and unconsciousness, until the patient sinks into complete stupor; and in exceptional instances of poisoning there is no stage of excitement, the patient at once falling into a condition of drowsiness, unconsciousness and stupor. As regards the spinal cord, in mammals there is observed some stimulation, followed by paralysis, but this is unimportant and does not occur until late. In the frog, on the other hand, the spinal paralysis is found to be so pronounced as to entirely obscure any effect the drug may have upon the higher nervous centres. The reflexes, which do not seem to be much affected at first, later disappear, and the animal lies completely paralyzed. The susceptibility to the effects of camphor varies very greatly in different individuals. .30 to .60 gm. (5 to 10 gr.) will produce in some persons a considerable amount of exhilaration, while in others the only effect observed will be a sense of comfort and restfulness.

Temperature.—In health the temperature is not affected, but in fever, camphor has, like many aromatic bodies, some antipyretic action.

Muscles.—On the striped muscles of the frog, when directly exposed to its solutions or vapor, camphor has a curara-like action, weakening and paralyzing them; but this is not observed in mammals. In certain experiments, made with a Mosso's ergograph, the drug sometimes seemed greatly to increase the energy and endurance of human muscles, but in other instances failed to have any influence.

Skin.—The fact that in those using camphor the sweat sometimes smells strongly of the drug points to some excretion of it by the skin. It has a mild **diaphoretic** action, and this may be due in part to its effects on the central nervous system.

Sexual Organs.—Occasionally camphor has the effect of inducing dysuria. In small doses it sometimes appears to increase the sexual appetite; but any such effect is probably to be attributed merely to its general stimulant action on the circulation. In large doses it has been held by many to be anaphrodisiac.

THERAPEUTICS OF CAMPHOR.

External.—On account of its stimulating properties, camphor is probably employed more extensively as an ingredient of liniments of various kinds than any other drug. Thus, as a mild irritant or counter-irritant it is rubbed into the skin, in one form or another, for the relief of internal inflammations, chronic inflammatory induration, chronic rheumatism, etc. In such conditions as myalgia, sciatica, lumbago and neuralgia of superficial nerves it also answers the same purpose, and in addition, by its effect in inducing local anæsthesia, serves to allay the pain. Camphor and hydrated chloral triturated together form a clear liquid which will take up morphine, atropine and other alkaloids in considerable quantity, and such a solution can be mixed with chloroform without precipitation. The resulting mixture constitutes a topical application of great power in the treatment of pain and inflammation; and it may be either painted on the affected part with a camel's-hair brush or applied on absorbent cotton or lint which is then covered with oiled silk. A Chloroformum Camphoræ may be prepared by dissolving camphor, 2, in chloroform, 1. The liquid preparations of camphor with hydrated chloral, thymol and phenol are excellent local anodynes for neuralgia, and may also be applied on cotton to the cavities of aching teeth. A warm flaxseed poultice to which camphor and morphine have been added is a good external application for the relief of toothache. The solution of camphor in ether has been applied locally with benefit in erysipelas, and powdered camphor, freely sprinkled over the surface, is sometimes successful in preventing pitting of the face from small-pox. Powdered camphor has also been used with success upon specific ulcers of the genitals, and is an efficient application for indolent ulcers. For the latter the camphor ointment of the National Formulary (camphor, 22; white wax, 11; lard, 67) may likewise be employed. Camphor, 14, combines with salicylic acid, 11, with the aid of heat, and in the form of ointment has been used in chronic ulcers and in lupus. In chilblains, ointments or liniments containing camphor are often useful. For chapping or roughness of the skin camphor may be employed in the form of Ceratum Camphoræ or incorporated in suet or lanolin. Either alone or in combination with other agents it is of service in relieving the itching of eczema and other cutaneous affections. A combination of camphor, 3, and phenol, 1, is a valuable antiseptic and anodyne dressing for wounds, and on account of its anæsthetic properties is useful in the treatment of inverted toe-nail. It may also be locally applied with benefit in pharyngitis or tonsillitis, herpes, erysipelas, vaginitis, vulvitis and paræsthesia of the vulva and other parts. It may likewise be used to overcome the fetor of lochial discharges. Fluids having valuable antiseptic powers are formed from camphor with phenyl salicylate or betanaphthol, and mixtures of camphor with menthol, of various strengths, are employed in acute nasal catarrh, pharyngitis and laryngitis, in hypertrophic rhinitis, and in diseases of the ear. The vapor of camphor is inhaled with some relief in coryza and also in some forms of headache. In the household the spirit or "eau sédative," applied on a handkerchief or a flannel bandage, is a popular remedy for headaches and various neuralgic pains. Camphor enters into the composition of many dentifrices.

Internal.—Camphor is contra-indicated in inflammatory diseases of the gastro-intestinal mucous membranes. It is much used as a carminative, particularly in neurotic individuals. A few drops of the spirit will often give relief in hysterical vomiting, and camphor water with compound tincture of lavender is an excellent remedy for flatulence, especially hysterical flatulence. With the addition of laudanum this mixture is very useful in ordinary diarrhœas. Camphor in combination with opium is very largely used in the treatment of diarrhœa, and even in the preliminary diarrhœa of Asiatic cholera has frequently proved of the greatest service. Hope's camphor mixture, when freshly made with nitrous, rather than nitric, acid, is a useful preparation and is especially well adapted for diarrhœa of relaxation in elderly subjects. Either rhubarb, capsicum, chloroform or some astringent is often added to the preparations of camphor and opium in diarrhœa mixtures. Camphor is very commonly used for aborting colds and in the treatment of cold in the head. A very good "cold powder" consists of camphor (dissolved in ether), 5; ammonium carbonate, 4; powdered opium, 1. The dose of it ranges from .20 to .60 gm. (3 to 10 gr.). It has been found of value in breaking up colds when taken in time, and in modifying their force when taken later. For the treatment of acute coryza an excellent combination consists of camphor, quinine and fluidextract of belladonna, administered in pill or tablet. As camphor tends to allay cough and promote expectoration, it is a common ingredient of cough mixtures and is much employed in the form of paregoric. Camphor is used especially in chronic bronchitis, emphysema, and capillary bronchitis. It has also been found of service as a stimulant in so-called typhoid pneumonia. It was formerly employed to a considerable extent in the treatment of asthma, but has now been superseded by other remedies which have proved more efficient. Administered with spirit of chloroform and compound tincture of lavender, spirit of camphor has been given with advantage in influenza. In typhus and typhoid fever and in the exanthemata generally it has long been used as a cardiac stimulant, and also for the purpose of quieting delirium, subsultus or restlessness. In Japan excellent results have been reported from the use of camphor, to the exclusion of other medication, in the treatment of typhoid fever, the observations extending over a period of five years. The regular amount administered daily was 1 gm. (15 gr.). In senile gangrene and hospital grangrene large doses of camphor have proved of value, while the powdered drug has been applied with advantage to the sloughing surfaces. According to some authorities, 2 gm. (30 gr.) a day may be given hypodermatically (in the form of a 10 per cent. solution of olive oil) in the profound adynamia of acute endocarditis, typhoid fever, pneumonia, etc., with the happiest result. It is stated that the addition of a few drops of camphor to a small enema of ordinary water will produce a prompt evacuation of the bowels. A clyster of camphor is also an effective remedy against thread-worms. The use of large doses of camphor in abnormal sexual excitement and in chordee, as well as in severe convulsive disorders such as whooping-cough, epilepsy and puerperal convulsions, has to a large extent passed out of vogue, though monobromated camphor is still successfully employed in some of these conditions. A full dose of camphor is sometimes given to arrest the strangury produced by cantharides used for blistering. Camphor is a common remedy in attacks of nervousness and hysteria, and in hysterical convulsions is a useful antispasmodic. In some cases of delirium tremens it works quite satisfactorily, but in maniacal excitement, melancholia and erotomania it is a very uncertain agent. It is extremely useful in nervous dysmenorrhœa and, combined with morphine, is commonly relied upon for the relief of after-pains. There are, indeed, many conditions met with in women to the alleviation of which no one remedy seems so well adapted as camphor. Monobromated camphor is used as a nervous sedative. Its action is not identical with that of the bromides, however, as the bromine is present in a different form, and it is stated that no bromine ion is liberated; so that the bromine effect would seem to be quite limited. Camphoric acid is successfully administered for colliquative sweating, *e. g.*, that of pulmonary tuberculosis. The daily amount of from 1 to 5 gm. (15 to 75 gr.) should be given very early in the evening in divided doses at short intervals, either dry upon the tongue or in starch wafers. It has been used with success also in hyperidrosis occurring in a variety of cases which were non-tuberculous.

MUSK.

MOSCHUS.—Musk. **Dose, 0.250 gm. = 250 milligm. (4 gr.)**

Preparation.

Tinctura Moschi.—Tincture of Musk. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF MUSK.

Musk is regarded as **stimulant** and **antispasmodic.** It is supposed to act in the same way as camphor, but almost nothing is definitely known in regard to this substance. The odoriferous matter, which is believed to be the active principle, has scarcely been examined. According to some early observations musk was found to cause headache, giddiness and confusion, with a feeling of weight and uneasiness in the stomach; later, depression and drowsiness, and eventually sleep. Tremors and even convulsive movements were also sometimes noticed, and the pulse was said to be accelerated and quickened.

THERAPEUTICS OF MUSK.

In recent years the use of musk has been almost entirely discarded. Its effects appear to be very uncertain at best, and as most of the musk on the market is adulterated, and moreover its price is extremely high, there would seem to be very little reason for retaining the drug in medicine. Its therapeutic use has always been almost purely empirical, and it has been suggested that it was probably thought that a substance with such a powerful odor could not but possess a marked physiological action, although no such action was ever demonstrated. Musk has been mainly used in spasmodic diseases, such as chorea, whooping-cough, hiccough, and laryngismus stridulus, and as a stimulant in asthenic conditions, especially in pneumonia and delirium tremens and in typhus, typhoid and other fevers. At present it is said to be most often prescribed for the extreme weakness which frequently follows typhoid fever. It is usually administered in pill.

I. DRUGS ACTING ON THE VAGUS CENTRE.

ACONITE.

1. **ACONITUM.**—Aconite. **Dose, 0.065 gm. = 65 milligm. (1 gr.)**

Preparations.

1. **Fluidextractum Aconiti.**—Fluidextract of Aconite. **Dose, 0.05 c.c. (1 m.).**

2. **Tinctura Aconiti.**—Tincture of Aconite. **Dose, 0.3 c.c. (5 m.).** Fleming's Tincture of aconite is nearly seven times stronger than the official.

2. **ACONITINA.**—Aconitine. **Dose, 0.00015 gm. = 0.15 milligm. (1/400 gr.).**

ACTION OF ACONITE.

The action of aconite is due chiefly to its constituent aconitine, which is recognized as the most toxic of all known alkaloids.

External.—Locally it is an irritant, but unlike other local irritants it does not cause redness, blistering or other sign of inflammation. Applied to the skin or mucous membrane, it soon affects the peripheral ends of the sensory nerves, causing itching, tingling and burning. This stimulation is followed by numbness and later by complete paralysis of sensation in the part. Inhaled through the nostrils, it gives rise to sneezing and symptoms of coryza, with an icy cold sensation.

Internal. Gastro-intestinal Tract.—When taken by the mouth it causes a disagreeable pricking and sense of constriction in the fauces. Other mucous membranes become affected and various reflexes, such as sneezing, coughing, increased flow of saliva, nausea and vomiting may be produced by the irritation of the sensory terminations. This stimulation is succeeded by a depression which gives rise to a sense of numbness in the different surfaces. Unless the dose is excessive, purging is not caused, and even then it occurs only in occasional instances.

Heart and Circulation.—The action of aconite on the heart is somewhat complex, and if given in sufficient amount it has the effect of successively stimulating and paralyzing all the different parts of the cardiac mechanism. Under small doses the only symptoms produced are those due to stimulation of the vagus centres in the medulla, the primary action of the drug. As a result, the rate of the heart is **slowed,** the **diastole** is **increased,** the systole is diminished, and there is a **fall in blood-pressure.** That these effects are due to stimulation of the inhibitory centres is shown by the fact that if the vagus is divided the heart-beat returns to the normal. With larger doses the primary slowing action is the same, but this is soon followed by results due to the direct action of the drug upon the heart itself, as well as its influence upon the vaso-motor centres. The rhythm becomes markedly accelerated, instead of abnormally slow. This acceleration has been attributed to paralysis of the vagus terminals, but that it is not due entirely or principally to this is shown by the fact that it occurs after section of the vagus. There is evidently a powerful stimulation of the cardiac muscle, and the action of the heart becomes not only very rapid but also extremely irregular. The blood-pressure likewise becomes exceedingly irregular, now falling and now rising again to a considerable extent. The contractions of both the auricle and ventricle are imperfect and very unequal, the one part often beating at a different rate from the other. The ventricular action tends to become more rapid than the auricular, and the increasing irritability of the heart eventually results in delirium cordis. Finally the vaso-motor centres become paralyzed and lose their function. There is always in the end a complete fall in pressure from paralysis of the heart and blood-vessels. Clinically it appears that the peripheral vessels are dilated, and this effect is sometimes very marked. Aconite has been named the "vegetable lancet."

Nervous System.—There is still considerable uncertainty as to the mode and order in which the different parts of the nervous system are affected by aconite, and one reason for this is that the symptoms due to the action of the drug on the central nervous system are to a greater or less extent obscured by its effects on the peripheral nerve terminals. On the cerebrum it has apparently but little influence. In cases of poisoning by it the intellectual faculties are not affected, and consciousness usually remains to the end. If the latter is lost or impaired, this may be due to changes in the circulation and respiration, or possibly to collapse resulting from paralysis of the medullary centres. Near the end, carbon dioxide narcosis may supervene. Aconite has decided effects on the medulla, and its action on the vagus centre has already been referred to. It is also believed that it affects the vaso-constrictor centre and that the vomiting so frequently present is due, at least in part, to increased irritability of the medullary centres. There is dilatation of the pupil, and this is regarded as due to stimulation of the central dilator apparatus, while the convulsions which are not infrequently observed are also attributed largely to central stimulation. The spasms have been thought to be chiefly respiratory, but the fact that they are not altogether absent in frogs, and not always relieved by artificial respiration in mammals, indicates, it is held, an effect, in part, central. The action of aconite on the spinal cord has not as yet been definitely determined, but the reflex function of the cord is apparently impaired by it. Some authorities hold that it primarily stimulates the motor portion of the cord, and at a very late period in its toxic action causes centric motor depression. Its action on the motor spinal cord, however, is believed to be entirely subservient to its influence on the peripheral nerves. The weight of evidence goes to show that it causes paralysis of the sensory nerves, commencing at their peripheral terminations and extending eventually to the centre of sensation in the cord, and that the loss of reflex activity noted is due, at least in great part, to the peripheral paralysis; furthermore, that the motor nerves, upon which it exerts a feeble depressing influence, are not affected until after the sensory nerves. Under toxic doses of aconite the special senses may be more or less interfered with, and the general sensibility is always greatly diminished, so that marked **anæsthesia of the surface** is a prominent characteristic.

Respiration.—In moderate doses aconite usually has the effect of quieting the respiratory movements. Under toxic doses the respiration is at first quickened, but soon becomes very slow and labored. When the full effect of the drug is produced both inspiration and expiration are prolonged, and the latter is followed by a long pause. Between the primary quickening and the subsequent permanent slowing the respiration is sometimes very irregular, and from the first there is always marked dyspnœa. The respiratory trouble has been shown not to be due to action on the phrenic terminations, and it does not result from stimulation of the vagus endings in the lungs, because section of the vagi does not prevent the slowing. It seems certain, therefore, that it is caused by the depressing action of the drug upon the respiratory centre in the medulla; and it has been found that paralysis of this centre begins early. It may sometimes occur that the heart ceases before the respiratory movements, but paralysis of the respiratory centre, rather than cardiac paralysis, constitutes the usual cause of death in aconite poisoning. The paralysis of this centre progresses more quickly than that of any other, and it is possible, therefore, for death to take place from asphyxia while the rest of the central nervous system still continues irritable, as shown by the occurrence of convulsions.

Temperature.—Attention has been called by certain observers to the peculiar effect (one that is unique) which aconite has of causing a chilly sensation that occurs before either the temperature or the circulation through the skin is changed. This, it is thought, must result from a stimulation of certain temperature nerves. Both in febrile conditions and in the normal state aconite has the effect of markedly **reducing** the **temperature.** It is not positively known in what manner this fall is brought about, but it seems probable that it is due in great part to the influence of the drug upon the nervous centres regulating heat production and to its action on the circulation. A considerable amount of radiation, it might be expected, would take place from the surface of the body in consequence of the lowering of the blood-pressure and dilatation of the peripheral vessels caused by it, and the increase of perspiration which is also one of its effects no doubt assists in the reduction of the temperature. The lessening of the supply of oxygen to the tissues occasioned by the interference with the circulation and respiration is shown by the cyanotic appearance of the mucous membranes, and this, it is believed, is largely instrumental in causing the fall.

Skin.—**Profuse sweating** is an almost constant symptom when large doses of aconite are taken. Whether it has any direct action on the perspiratory glands or not is not definitely known, but the dilatation of the cutaneous vessels to which reference has been made would seem, by increasing the blood-supply of the parts, to facilitate an increased sudoriparous excretion. It is probable, therefore, that aconite does have some positive diaphoretic action, but, even if this is the case, the cold perspiration so commonly observed is undoubtedly largely attributable to the collapse induced by the drug. In occasional instances an erythematous rash is caused by it.

Kidneys.—Aconite has some influence on the kidneys, but this diuretic action is one of its minor effects. It thus increases elimination to a certain extent, and not only the watery, but the solid constituents, of the urine are said to be augmented by it. Aconitine is excreted mainly through the kidneys.

Benzaconine.—Benzaconine is very much less poisonous than aconitine, the toxic effect of the latter being found by experiment to be nearly two hundred and fifty times greater in warm-blooded animals. In many of its actions it is also distinctly opposed to aconitine. It slows the pulse-rate, and its special effect on the heart, when given in sufficient quantity, is to retard the systole of the ventricles, so that eventually there may be only one beat of the latter to two or even three of the auricles. Section of the vagus, it is found, does not materially affect this action, which therefore appears to be chiefly on the cardiac muscle, and which naturally occasions a marked reduction of blood-pressure. The alkaloid is thus the physiological antagonist of digitalin. It depresses the vaso-motor centre, but this occurs quite late in its toxic action. It acts powerfully on the motor nerves, but affects the sensory nerves only at a late stage, if at all. By some of the best authorities it is denied that it has any influence on the sensory terminations, and practically it is found that it does not produce tingling or numbness of the mucous membranes. Unlike aconitine, it gives rise to a lethargic or semi-comatose condition. In very large doses it has a depressing effect upon respiration, but it causes a very slight reduction of temperature.

Aconine.—This is a very feeble agent, but, given in sufficient quantity, it has the effect of strengthening the heart-beat. Its action is distinctly opposed to that of aconitine, as it stimulates ventricular contraction and so tends to prevent cardiac asequence and inco-ordination. It does not affect the vaso-motor centre, but has a stimulating effect on the roots of the vagi. Like curare, it paralyzes the terminations of the motor nerves, the suspension of function lasting for a considerable time; but the paralysis is not preceded by any excitement or spasmodic action. When death is caused by it this is in consequence of failure of the respiration, which is probably of peripheral origin, rather than dependent upon depression of the respiratory centre in the medulla. It is thought to be unlikely that the alkaloids aconine and benzaconine have any influence on the action of aconite preparations, but the question is still an undecided one.

THERAPEUTICS OF ACONITE.

External.—The benumbing effects of aconite when locally applied have naturally suggested its external use in a variety of painful affections, and it is sometimes of considerable service, especially in facial and other neuralgias. Among the other conditions in which it has been employed are pruritus, prurigo, papular eczema, chilblains and herpes zoster. In the last-named affection care must be taken not to apply it to ruptured vesicles, and any preparation containing it should be used with great caution, if at all, upon an abraded cutaneous surface, on account of the danger of absorption. It is also used locally for the relief of the pain of chronic rheumatism, gout, myalgia, and inflammations of the structures of the eye and ear. In the different conditions mentioned above it may be applied either in the form of the tincture or in an ointment or liniment. The aconitine ointment (aconitine dissolved in alcohol, 1; oleic acid, 8; benzoinated lard, 41) is a very expensive preparation, and as a substitute for this the liniment (a 40 per cent. solution of powdered aconite root in alcohol, to which 2 per cent.

of camphor is added), may be painted on with a camel's hair brush. Other useful liniments are the Linimentum Aconiti Compositum (not official), known as A. B. C. liniment because it contains equal parts of aconite, belladonna and camphor liniments, and the "Baltimore liniment," consisting of tincture of aconite and chloroform with soap liniment. Occasionally deep-seated pains, such as syphilitic pains in the bones and those due to sciatica, are relieved by such liniments or by aconitine ointment, and sometimes veratrine may be advantageously combined with aconitine in local applications.

Internal.—While aconite is contra-indicated in all cases where the heart is weak and in adynamic conditions in general, it has a considerable range of usefulness, and it would seem probable that at the present time it is not employed to as great extent as it really deserves. In the early stages of acute inflammatory diseases it often acts very happily, and the more promptly it is resorted to the greater will be the benefit derived from it. It reduces the temperature and the arterial tension, quiets the heart, allays pain by its influence on the sensory nervous system, and promotes elimination by its action on the skin and kidneys. By its additional effect of slowing the respiratory movements it is of special value in some of the acute affections of the organs of respiration, the work of which is thus materially lessened. Among the conditions in which it can be used with advantage, if administered sufficiently early, may be mentioned coryza, pharyngitis, tonsillitis, bronchitis, pleurisy, pericarditis, gonorrhœa, urethral fever resulting from the passage of instruments, congestion and inflammation of the liver, peritonitis, puerperal metritis and peritonitis, inflammation of the cerebral or spinal meninges, cerebro-spinal meningitis, and the active fever of acute cerebral congestion. It will be understood, however, that it should never be given when the disease present is of an adynamic type, nor should its use be continued after effusion has taken place in the serous inflammations or after the febrile movement has abated in the others. The best preparation for internal use is the tincture, and the exhibition of this in minute quantities at frequent intervals during the day, followed by a full dose of Dover's powder at night, is considered one of the best ways to "break up a cold." In catarrhal and fibrinous pneumonia it is more particularly useful before exudation has occurred, but may sometimes be continued afterward in order to combat the inflammatory processes. In acute pleurisy before the stage of effusion and in some other inflammations, notably peritonitis, great benefit may be derived by combining it with some preparation of opium, such as the deodorized tincture. In what are known as irritative fevers, especially among children, it is an extremely useful remedy. In small and repeated doses it usually brings about a free diaphoresis, and then the temperature promptly falls. It has been highly commended in the early stage of scarlatina, as not only reducing the temperature and acting favorably on the skin and kidneys, but also checking the nasal, faucial and aural inflammations which often constitute such serious complications and sequelæ of the disease. In measles it sometimes serves the purpose of arresting the catarrhal pneumonia which is one of the most dangerous complications of this affection. At times it is also of service in the hot stage of the paroxysms of malarial fever. In typhoid and other continued fevers of asthenic character it should be carefully avoided, and it is also contra-indicated in inflammatory conditions of the gastro-intestinal mucous membrane. One of the diseases in which it has been employed with the best effect is erysipelas of the non-traumatic variety, and especially facial erysipelas. When, however, the affection is of an adynamic type and the eruption presents a dusky appearance, belladonna should be resorted to instead of aconite. Aconite may be of service in acute rheumatism when there is much heat and a dry skin, instead of the more common sweating, and if it is desirable to bring about a very free action of the skin it is recommended to combine it with pilocarpine and antipyrine. It is also sometimes beneficial in muscular rheumatism when there is considerable temperature.

In conditions in which there is high arterial tension, chiefly of cardiac origin, aconite is a remedy of the greatest possible value. It is especially indicated in cases without valvular disease in which there is hypertrophy and over-action of the heart, and likewise when with valvular disease there is excessive compensation. It is particularly useful in cardiac neuroses. In simple nervous palpitation of the heart it is of great service, and it has sometimes also been found to relieve the pain of aneurism. While it has the power of allaying over-excitement of the sensitive nerves, it has little effect in relieving such affections as migraine, where the pain is of central origin. It has a certain amount of value in the treatment of neuralgias, but is generally less efficient when given internally than when locally applied, and is inferior in such affections to some other remedies at our command. It should be stated, however, that very satisfactory results have been reported from the use of Duquesnel's aconitine in trigeminal neuralgia. While not affording relief in all cases, in a considerable proportion of instances it was found to be remarkably successful. It is of more or less service in acute maniacal delirium and other mental affections, where vascular excitement and high arterial tension are present, but gelsemium has proved more efficient in this class of cases. It sometimes has an excellent effect in controlling the vomiting of pregnancy, and this has generally been attributed to its influence upon the peripheral sensory system, but may perhaps be due to its action in benumbing the sensory reflex centres. In gonorrhœa it is thought to prevent chordee by its effect on the nervous centres. It may prove useful in spasmodic croup, and in certain cases of asthma, if administered early, it affords relief. It sometimes acts well in acute suppression of the menses from cold, and it has been found a valuable remedy in congestive dysmenorrhœa in the full-blooded. In epistaxis occurring in plethoric subjects it is also of service. Finally, aconite is said to be an antidote to the sting of the scorpion.

TOXICOLOGY.

Symptoms.—If the dose is sufficiently large, death (probably due to cardiac paralysis) may occur almost instantaneously. When the quantity taken is smaller, the effects of the drug are soon felt. The characteristic burning and prickling in the mouth, followed by a sense of numbness, extends to the stomach, and eventually to the skin. There is a profuse flow of saliva and in some cases vomiting, while the cutaneous surface becomes covered with a cold sweat. The pulse, at first slow as well as feeble, may afterwards become very rapid and scarcely perceptible. The respiration is labored, shallow, and accompanied by marked dyspnœa. The patient's face is pale and anxious and there are great restlessness and general distress, with a sense of extreme fatigue and a loss of muscular power. With tingling and numbness in the extremities and more or less over the surface, there is a diminished sensibility to pain. The pupils remain dilated. Convulsions frequently precede death, which is generally due to paralysis of the respiratory centre, perhaps aided by anæmia of the medulla, but may be caused by paralysis of the heart. Under lethal doses the fatal result usually occurs in from two to six hours.

The post-mortem appearances met with are not constant, but are generally such as are characteristic of death from asphyxia.

Treatment.—Emetics may be tried, but will probably fail on account of the benumbed condition of the gastric mucous membrane. If the symptoms are very severe, it is better not to attempt to excite vomiting, on account of the risk of its causing fatal syncope. The stomach must therefore be evacuated by means of a stomach-pump or tube. The patient should be kept flat on his back, with the feet somewhat higher than the head, and artificial respiration should be resorted to as soon as difficulty of breathing occurs. His body should be wrapped in blankets and hot water bottles applied to the soles of the feet, or other means employed to maintain the temperature. Tannic acid is to some extent an antidote to aconite and may be tried; but is not to be depended upon. The main reliance must be upon stimulation. By the mouth ammonia and alcoholic stimulants may be administered, and for hypodermatic use it is recommended that ether, alcohol, and digitalis be given in the order named; the ether acting most promptly and supporting the heart until the alcohol can be absorbed, and the alcohol continuing the support until the digitalis, which is the physiological antagonist of aconite but acts slowly, has had time to produce its effects. In addition, strychnine should also be given subcutaneously in full doses, as a stimulant to the heart and respiration. If the case seems to require it, ammonia may be injected into the veins, and the inhalation of amyl nitrite may be cautiously employed. Other agents which partially antagonize the effects upon the heart and respiration are caffeine and atropine.

VERATRUM.

1. **VERATRUM.**—Veratrum. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Preparations.

1. **Fluidextractum Veratri.** — Fluidextract of Veratrum. **Dose, 0.1 c.c. (1½ ♏).**

2. **Tinctura Veratri.**—Tincture of Veratrum. **Dose, 1 c.c. (15 ♏).** (Norwood's Tincture of Veratrum is four and one-half times stronger than the official.)

2. **VERATRINA.**—Veratrine. **Dose, 0.002 gm. = 2 milligm. ($\frac{1}{30}$ gr.).**

Preparations.

1. **Oleatum Veratrinæ.**—Oleate of Veratrine.
2. **Unguentum Veratrinæ.**—Veratrine Ointment.

ACTION OF VERATRUM.

The alkaloids of veratrum have been the subject of considerable discussion, but according to the latest authorities, while jervine is known to have some action on the system, the activity of the drug is really due to veratrine. The latter has a chemical composition similar to aconitine, and has practically the same action on the central nervous system and the sensory terminations, but shows, in addition, a peculiar action in prolonging the relaxation of striped and cardiac muscle, which is entirely absent in aconitine poisoning. The action of veratrum and veratrine may, therefore, be considered together.

External.—Applied to the skin the alkaloid veratrine, and to a less degree the drug itself, produces a feeling of warmth and prickling, followed by a sensation of coldness and by numbness and anæsthesia. Applied to the mucous membrane of the nose and throat, it causes violent **sneezing** and **coughing**, and a minute portion placed upon the tongue gives rise to burning pain and free **salivation.** These phenomena, as in the case of aconite, are due to **stimulation** of the peripheral endings of the **sensory nerves.**

Internal.—*Gastro-intestinal Tract.*—When full doses are taken there are produced burning in the mouth, which spreads to the stomach, well-marked salivation, **nausea** and **vomiting,** and generally **purgation** accompanied by severe colic. The retching and vomiting, which are violent and persistent, have been attributed by some to central action and by others to irritation of the sensory nerve endings, and it seems probable that both of these are concerned in their causation. It has been supposed that the drug increases the biliary secretion, but the amount of bile often noted in the vomit may be simply due to the severity of the emesis, which causes the evacuation of the contents not only of the stomach but of the gall bladder also.

Muscles.—There is marked prolongation in the relaxation of muscles after contraction, which takes place normally, but is more complete than under ordinary circumstances. If a tracing be taken of the contraction of a muscle it will be seen that the height of the contraction is slightly increased, and that instead of the almost instantaneous return to the base-line seen in the normal tracing, the curve shows generally a slight undulation and then a very slow fall, the period of relaxation being from twenty to thirty times as long as in the unpoisoned muscle. This prolonged relaxation would at first sight appear like tetanus, but is entirely free from any element of spasm or rigidity. It has been found that it is accompanied by an increased formation of heat and use of material, and that it is lessened by fatigue, cold and other muscle-depressing agents, while increased by moderate heat. It must therefore be looked upon as an expression of greater functional activity, a **prolonged contracture** rather than a loss of elasticity. The irritability and absolute strength are also increased, so that the muscle reacts to weaker stimuli and contracts against a greater weight than usual. That the phenomena noted are not due to any nervous influence is shown by the fact that excised muscles show exactly the same reaction. It has been found that in the frog the muscles are finally paralyzed, but that this does not occur in mammals because in them the respiratory centre fails long before the quantity of veratrine necessary to produce this effect has been absorbed.

Heart and Circulation.—In the frog's heart the ventricular muscle is affected by veratrine in very much the same way as ordinary striated muscle. The auricular muscle, consisting for the most part of unstriated fibres, is much less powerfully influenced by it, and in consequence the auricle is found to make two, or even three, beats to one of the ventricle. In the mammalian heart, investigation shows that there is no such prolongation of the systole as is seen in the frog, but it has been proved that a slight stimulating action is exercised by the drug. The principal cardiac effects observed, however, are due to the influence exerted upon the medullary centres. As in the case of aconite, there is a primary stimulation of the vagus centre, resulting in a **slowing** of the heart's rate and a **reduction of arterial pressure.** At the same time, constriction of the peripheral vessels is produced through stimulation of the vaso-motor centre. After larger quantities the pulse is accelerated, the vaso-motor centre being depressed and the terminations of the vagus paralyzed. If, in the human subject, while it is depressed the posture is changed from the recumbent to the upright, the pulse at once becomes extremely rapid and thready.

Respiration.—The effects on respiration, due to depression of the respiratory centre in the medulla, are much the same as those of aconite. The breathing is slow and labored and attended with dyspnœa, and after lethal doses death usually results from paralysis of respiration.

Nervous System.—That the drug has decided actions on the medullary centres has already been seen. It also has a stimulating effect on the spinal cord, but the influence exerted by it on the highest cerebral centres is probably but slight, though the convulsions produced by it are believed, as in the case of aconite, to be due to central stimulation. It acts to some extent on the motor nerves, and its effects on the sensory nerve endings have been previously mentioned. After large doses the stimulation of the central and peripheral nervous system is succeeded by paralysis.

Skin.—It produces **free sweating,** but this is probably the result of arterial depression, rather than of any specific diaphoretic action.

Temperature.—There is generally under its influence a considerable reduction in temperature, which is thought to be due to the increased heat-dissipation resulting from vaso-motor paralysis and the slowing of the circulation. In cases, however, where the convulsions are marked, increased heat-production is caused by the violent movements, and the temperature is even higher than normal.

THERAPEUTICS OF VERATRUM.

Veratrum is a prompt and sure circulatory depressant, and its administration is safe because, the physiological action of the drug giving warning of danger, its use can be stopped in time to prevent accidents. In cardiac cases where there is excessive hypertrophy, and drugs of the digitalis class are contra-indicated, it is less advantageous than aconite, which is more persistent in its effects and not so apt to cause gastric disturbance, but in a number of other affections where the aim is to reduce arterial action it is held in deservedly high repute. Thus, in the early stages of sthenic croupous pneumonia it has long been considered one of the most reliable of remedies, quieting the increased action of the heart, lowering the temperature, and lessening the congestion of the lung. It may also be used with advantage, if given sufficiently early, when only hyperæmia is present, in pleurisy, hepatitis, cerebritis, maniacal delirium, *mania à potu,* with strong, bounding pulse, and other sthenic conditions. If its employment is maintained after the primary stage of congestion, however, it can only do harm. In acute gastritis and peritonitis it is generally contra-indicated on account of its irritating effect upon the stomach, though in peritonitis it may sometimes be of service if carefully watched. In aneurism where there is marked disturbance of the circulation and high pressure its cautious use is recommended, to decrease the pressure and prevent rupture of the diseased vessel; and it may prove a valuable adjunct to rest and other means of treatment. The production of vomiting should be avoided, if possible, and the patient should therefore be kept in a strictly recumbent position, while a small amount of opium may be given with the remedy. With the various surgical expedients, such as forced flexion, compression and ligation, for the cure of aneurism it has also sometimes been employed, with excellent results, for lessening the force of the blood-current and the rapidity of the pulse-rate. The action of veratrum is regarded as similar to a depletion, but without the permanent loss of blood, and on account of its influence in causing depression it has been designated as "the younger brother of tartar emetic."

The very marked efficiency of the drug (especially in the form of Norwood's tincture) in puerperal eclampsia has been attested by a large accumulation of the most trustworthy evidence, and by many physicians it is considered by far the best remedy at command in this condition. Its good effects have generally been attributed mainly to the depressing influence of the drug upon the motor tracts of the spinal cord, but while this influence no doubt contributes in some measure to the beneficial results, its action in this respect is neither so certain, [illegible] or sure as a number of other drugs, and its effect must therefore be regarded as due to a very considerable extent to its action on the circulatory system. In puerperal convulsions the spasmodic condition is generally associated with abnormally high intravascular tension, and veratrum would [illegible], seem to be especially indicated. In this affection it has been pointed out that it possesses the double recommendation (1) that it affords a certain and rapid means of lowering the blood pressure; (2) that although it is not cumulative to any marked degree, its action is long maintained, and may be perpetuated by a repetition of small doses. Sometimes, however, quite large doses are well borne, and successful cases have been reported where as much as 1.20 c.c. (20 m) of [illegible] has been given every hour for five consecutive days and nights. In the early stage of peritonitis, phlebitis and other inflammations, affections of the puerperal state it may also prove [illegible] if there is no cardiac weakness or general adynamia. Among the various other diseases in which its early use is said to have been attended with satisfactory results are acute rheumatism and tonsillitis, in the latter instance combined with morphine. It has also been given in the case of certain wounds which tend to dangerous results, like those of the head, pericardium, heart and peritoneum, with the idea of securing, by means of the diminished arterial movement caused by it, as little motion of the affected part as possible. It should never be employed to produce vomiting, as it is too harsh and depressing in its effects. Notwithstanding the criticisms of those who regard it as a type of those cardiac sedatives which tend, it is claimed, to retain in the blood all that is injurious in it and at the same time to reduce the patient to a state of utter wretchedness, veratrum undoubtedly has a legitimate, though limited, field in therapeutics, and, within its proper range, is still esteemed by a large number of practitioners as a remedy of great value.

Therapeutics of Veratrine.

External.—Veratrine (as an oleate or ointment) is chiefly employed, either alone or in combination with other remedies, in the external treatment of neuralgia, myalgia, herpes zoster, acute gout, and other painful affections. Used locally it has also been found of service in alopecia circumscripta, chloasma, and chronic swelling and stiffness of the joints. For ordinary use the official ointment is too strong, and should be reduced one-half or more, or the oleate may be substituted for it. In a weakened form it is sometimes employed in infantile paralysis, for the alleged purpose of improving the nutrition of the affected muscles. In the external application of veratrine preparations care should always be taken to avoid abrasions of the cuticle, on account of the danger of absorption. They should likewise be used with caution near the eye, as violent inflammation of the conjunctiva will be set up if any of the veratrine comes in contact with it.

Internal.—Veratrine is very rarely given internally. It has, indeed, been suggested by one authority that as its activity is due to this alkaloid, veratrum might well be dropped from the Pharmacopœia, but the fact remains that veratrum is still held in high repute as a circulatory depressant, while veratrine is practically discarded. Probably the chief reason for this is the dangerousness with which the alkaloid is regarded, and it is authentically recorded that alarming symptoms have been produced by a dose of only 0.004 gm. ($\frac{1}{16}$ gr.).

TOXICOLOGY.

Notwithstanding the severity of the symptoms caused by it, and although it has often been given with great freedom, fatal results have very seldom been noted from the use of veratrum. This is probably explained, at least to a considerable extent, by its prompt ejection from the stomach in consequence of the emesis produced by large doses taken by the mouth. As most of the symptoms of poisoning by the drug have already been given, a further detailed description is unnecessary. There is often very severe abdominal pain, and headache and giddiness are common. There may or may not be muscular twitchings. After veratrine especially the convulsive movements are sometimes very marked. There is extreme debility, the features are pinched, and there is usually great pallor, with a cold and clammy skin. The medullary and spinal centres become paralyzed, and death results from respiratory collapse, adjuvated by failure of the circulation. The post-mortem changes are not characteristic.

Treatment.—The treatment is practically the same as in aconite poisoning, though the contents of the stomach are usually efficiently evacuated by the action of the drug itself. Atropine has proved of some value in the poisoning of animals by veratrine, and its use is suggested on account of its action on the respiratory centre and on the vagus terminations in the heart. As the poison is rapidly excreted through the urine, it has also been recommended to administer hot tea as a diuretic.

C. Drugs Acting on the Accelerating Centre.

CACTUS.

Cereus Grandiflorus.—Cereus Grandiflorus (not official). (Night-blooming Cereus.) **Dose, 0.30 to 0.60 gm.; 5 to 10 gr.**

Unofficial Preparation.

Fluidextractum Cacti.—Fluidextract of Cactus. **Dose, 0.60 to 2 c.c.; 10 to 30 ♏.**

Action of Cactus.

Cactus is non-irritating, but the crude drug is said to be used as a counter-irritant, and to produce pustulation. The action of cactus is upon the intra-cardiac ganglia and accelerator nerves, through the cardiac plexus of the sympathetic, and there is not any interference with the inhibitory nerves, nor, indeed, does its administration produce any very marked vasomotor changes. It shortens the ventricular diastole, thus quickening the pulse, and increases the blood-pressure. It is also said to have a stimulating effect upon the spinal nerve-centres, and to increase the general nerve-tone.

Therapeutics of Cactus.

Cactus is useful in cardiac weakness, that is, valvular incompetency; in convalescence from typhoid fever; in simple [illegible] tric cardiac dilatation; in functional cardiac diseases, from tea, coffee, tobacco and alcohol, dyspepsia, exophthalmic goitre, neurasthenia or the climacteric, sexual exhaustion; in the "slow heart," from over-stimulation of the pneumogastric or degeneration of the muscular wall of the ventricles. It is of very great use in aortic regurgitation, but is absolutely contra-indicated in mitral stenosis, thus being of value in those cases where the use of digitalis is inadmissible. It has also been found of service in some cases of angina pectoris, more particularly pseudo-angina. Cactus has a sphere of action entirely its own; not, however, replacing other remedies used for cardiac disease, though it is useful in many cases where these drugs are not only dangerous, but absolutely contra-indicated. Failures to obtain results depend upon the fact that many adulterated specimens are found in the shops, or upon the use of inert, dried material. If made from the green plant, as it should always be, the fluid-extract is of a peculiar green color. Cactus, in the form of this preparation, is the only remedy known which will quicken a slow heart. It deserves a better recognition in cases of this kind, few indeed, yet nevertheless presenting themselves, for in such it oftentimes yields brilliant results.

DIVISION IV.—DRUGS ACTING ON THE VESSELS.

The effects are usually determined (1) by direct observation of alterations caused by the drug in the size of the vessels of some thin structure, such as the ear of the rabbit, the wing of the bat, or the web, lung, mesentery, tongue or mylo-hyoid muscle of the frog; (2) by observing the rate at which the blood flows from the cut vessel of an animal, both under and without the influence of the drug. In order to exclude influences acting on the cardiac mechanism, the maintenance of an artificial circulation is quite commonly resorted to, and destruction of the spinal cord or section of the nerves supplying the part is required to determine whether the changes observed are due to local or central effects. When alterations in the vessels result from the local application of a drug it is often uncertain, if the nerves supplying the part are not divided, whether the effect is reflex or direct. It is probable that some of the drugs act by the vaso-constrictor and some by the vaso-dilator nerves, both of which kinds of nerves connect the vessels with the central nervous system; but they can be classified only generally into those drugs which dilate or constrict the vessels by local action and those which do so through their action on the central nervous system. In the case of those acting locally it is impossible to determine whether they affect the muscular coat of the vessel or the nerve terminations. It can readily be seen that drugs which act on the heart or on a large area will have a considerable effect upon the general blood-pressure. Drugs are applied to the interior of vessels by injecting them into the circulation.

A. Drugs acting locally on Vessels.

1. Vaso-dilators.

a. Drugs which, when locally applied to vessels, dilate them:

(1) **Solution of ammonia.**
(2) **Silver nitrate**
(3) **Zinc chloride** (strong).
(4) **Copper sulphate**
(5) **Mercuric nitrate.**
(6) **Arsenic trioxide.**
(7) **Antimony and potassium tartrate.**
(8) **Iodine.**
(9) **Chlorine.**
(10) **Mineral acids** (strong).
(11) **Alcohol.**
(12) **Ether.** If prevented from evaporating.
(13) **Chloroform.**
(14) **Phenol.**
(15) **Creosote.**
(16) **All volatile oils,** as oils of turpentine, and many substances containing them, as mustard, etc.
(17) **Senega.**
(18) **Chrysarobin.**
(19) **Ipecac.**
(20) **Capsicum.**
(21) **Croton oil.**
(22) **Camphor.**
(23) **Cantharides.**
(24) **Phosphorus.**
(25) **Warmth,** if transiently applied. (When long applied it contracts blood-vessels.)

Irritants.—All of the above, as they dilate the vessels, are often spoken of as **vascular irritants.**

Rubefacients are drugs which, in consequence of the vascular dilatation caused by them, redden the skin when they are applied to it. Desquamation frequently follows if the action has continued for some time. All the above are rubefacients.

Vesicants.—With many of these drugs the irritant effect is sufficient to produce inflammation, and when they cause the exudation of serum between the epidermis and the true skin and the formation of vesicles or blisters they are known as vesicants; *e. g.*, cantharides.

Pustulants are drugs which produce small discrete suppurations, the distinct and separate points of inflammation being situated at the orifices of the skin glands. They do not affect the intervening tissue, probably for the reason that they cannot pass through the horny epidermis; *e. g.*, croton oil.

Escharotics.—With the most powerful of these drugs the irritation is sufficient to destroy the vitality of the tissues with which they came in contact, forming a slough, and to cause vascular dilatation in the surrounding parts. They are known as eschartics or caustics; *e. g.*, zinc chloride.

Counter-irritants.—When any of these drugs are employed to produce a reflex influence on a part more or less remote from the point of application, they are termed counter-irritants. The exact nature of the effects of counter-irritation on internal organs has not been determined, but it is considered most probable that an alteration in the calibre of the vessels and in the sensory nerves or their terminations is induced, and that such changes may cause or be accompanied by a distinct alteration in the activity of the organs.

The following, when inhaled, dilate peripheral vessels by acting locally on them:

(1) **Amyl nitrite.**
(2) **Nitroglycerin.**
(3) **Sodium nitrite.**
(4) **Ethyl nitrite.**
(5) **Spirit of nitrous ether.**
(6) **Erythrol nitrate.**

b. Drugs which, taken by the mouth, dilate arterioles by acting locally on them:

(1) **Amyl nitrite.**
(2) **Nitroglycerin.**
(3) **Sodium nitrite.**
(4) **Ethyl nitrite.**
(5) **Spirit of nitrous ether.**
(6) **Erythrol nitrate.**

From a medical standpoint these are the most important of the vasodilators.

2. Vaso-constrictors.

a. Drugs which, when locally applied to vessels, contract them:

These may act in two ways: (1) by contracting the muscular coat of the vessels; (2) by coagulating the albuminous fluids around them, the coagulum by its contraction constricting the vessels.

Those which act on the muscular coat of the vessels:

(1) **Cold,** temporarily applied. (If cold is long continued it dilates blood-vessels.)
(2) **Cocaine.**
(3) **Lead salts.**
(4) Dilute solutions of **silver salts.**
(5) **Diluted sulphuric acid.**
(6) **Alum.**
(7) **Hamamelis.**
(8) **Ergot.**
(9) **Hydrastis.**
(10) **Acetanilide.**
(11) **Antipyrine.**

Those which coagulate the albuminous fluids around the vessels:

(1) **Tannic acid** and all substances containing it: *e. g.*, nutgall, krameria, kino, hæmatoxylon, hamamelis, cinnamon, eucalyptus gum, and gambir.
(2) **Lead** salts.
(3) **Silver** salts.
(4) **Zinc** salts.
(5) **Copper** salts.
(6) **Alum.**
(7) **Ferric** salts.
(8) **Bismuth** salts to a slight extent.

Astringents are drugs which diminish the size of the vessels, and thus decrease the amount of exudation from them. They produce contraction of muscular fibre by direct irritation and condensation of other tissues by precipitating albumin and gelatin.

b. Drugs which, taken by the mouth, contract arterioles by acting locally on them:

(1) **Suprarenal extract.**
(2) **Barium salts.**
(3) **Ergot.**
(4) **Digitalis.**
(5) **Physostigmine.**

The following have been shown by experiments to cause contraction of small arteries through which they circulate: copper, zinc, tin and platinum salts (powerful contraction); lithium, calcium, strontium, magnesium, cadmium, nickel, cobalt and iron salts (slight contraction).

Styptics, or **Hæmostatics,** are drugs which stop bleeding. Among them are included all astringents, the most important of them being cold, lead and copper salts, hamamelis, ergot, hydrastis, tannic acid, and especially iron salts, which coagulate escaping blood, while the clot thus formed tends to prevent further hæmorrhage. Matico leaves, applied to a bleeding surface, act as a mechanical hæmostatic, the numerous hairs on their underside favoring coagulation; and cobwebs have a similar effect.

3. Emollients and Demulcents.

Emollients are substances which soften and relax the parts to which they are applied. They serve to relieve tension, diminish pressure on the nerves, and also protect inflamed surfaces from the air and from friction.

Common emollients are substances soaked in warm water, as hot fomentations and poultices, fats of various sorts, as lard and hydrous wool-fat, and non-irritating oils, as olive oil, petrolatum, vaseline, etc.

Demulcents are substances which protect and soothe the tissues to which they are applied, and are often of a mucilaginous nature. This name is ordinarily employed for substances used for mucous membranes, and that of *emollient* for those used for the skin. Among demulcents may be mentioned gelatin, glycerin, gum, honey, flaxseed, starch, and white of egg.

Therapeutics.—Drugs which locally dilate vessels are frequently used as stimulating applications for indolent ulcers and sores, as well as to promote the absorption of inflammatory products; also as counter-irritants in various diseased conditions in internal organs. Drugs such as the nitrites, which by their central action cause dilatation of all the vessels of the body, are employed in cardiac diseases, where the relief which they afford is no doubt largely due to their thus diminishing the work of the heart. Others having this general vaso-dilator action are used more particularly to cause diaphoresis.

Astringents are used chiefly as styptics, but also to diminish secretion from mucous membranes and check excessive discharges generally, as well as to obviate relaxed vascular conditions.

B. Drugs which act on the Vaso-motor Centres.

Drugs which, by their action on the vaso-motor centres, dilate the vessels:

(1) **Belladonna.**
(2) **Stramonium.**
(3) **Hyoscyamus.**
(4) **Alcohol.**
(5) **Ether.**
(6) **Chloroform.**
(7) **Hydrated chloral.**
(8) **Antimony and potassium tartrate.**
(9) **Aconite.**
(10) **Ipecac.**
(11) **Lobelia.**
(12) **Tobacco.**
(13) **Veratrine.**
(14) **Hydrocyanic acid.**
(15) **Opium.**

Some of the substances which in small doses contract the vessels by central action, in large doses dilate them; viz., digitalis and squill.

Drugs which, by their action on vaso-motor centres, cause contraction of vessels:

(1) **Ergot.**
(2) **Digitalis.**
(3) **Strophanthus.**
(4) **Sparteine.**
(5) **Squill.**
(6) **Physostigmine.**
(7) **Cocaine.**
(8) **Hydrastis.**
(9) **Hamamelis.**
(10) **Strychnine.**
(11) **Lead salts** } (slightly).
(12) **Ammonia** } (slightly).

Also, for a very short early period of their action, some substances whose main action is to dilate the vessels by their central action; viz., belladonna, stramonium, hyoscyamus, alcohol, ether, chloroform, hydrocyanic acid, and veratrine.

A. DRUGS ACTING LOCALLY ON VESSELS.

(*a*) Acting locally.

I. Vaso-dilators.

THE ACIDS.

1. ACIDUM SULPHURICUM. Sulphuric Acid. (Oil of Vitriol.)

Preparations.

1. Acidum Sulphuricum Aromaticum. Aromatic Sulphuric Acid. **Dose, 1 c.c.** (15 ♏).

2. Acidum Sulphuricum Dilutum. Diluted Sulphuric Acid. **Dose, 2 c.c.** (30 ♏).

2. ACIDUM NITRICUM. Nitric Acid.

Preparations.

1. **Acidum Nitricum Dilutum.**—Diluted Nitric Acid. **Dose,** 2 c.c. (30 ♏).

2. **Acidum Nitrohydrochloricum.**—Nitrohydrochloric Acid. (Nitromuriatic Acid.) **Dose,** 0.2 c.c. (3 ♏).

3. **Acidum Nitrohydrochloricum Dilutum.**—Diluted Nitrohydrochloric Acid. **Dose,** 1 c.c. (15 ♏).

3. **ACIDUM HYDROCHLORICUM.**—Hydrochloric Acid. (Muriatic Acid.)

Preparations.

1. **Acidum Hydrochloricum Dilutum.**—Diluted Hydrochloric Acid. **Dose,** 1 c.c. (15 ♏).

2. **Acidum Nitrohydrochloricum.**—Nitrohydrochloric Acid. **Dose,** 0.2 c.c. (3 ♏).

3. **Acidum Nitrohydrochloricum Dilutum.**—Diluted Nitrohydrochloric Acid. **Dose,** 1 c.c. (15 ♏).

4. **ACIDUM PHOSPHORICUM.**—Phosphoric Acid.

Preparations.

1. **Acidum Phosphoricum Dilutum.** — Diluted Phosphoric Acid. **Dose,** 2 c.c. (30 ♏).

2. **Elixir Ferri, Quininæ et Strychninæ Phosphatum.**—Elixir of the Phosphates of Iron, Quinine et Strychnine. **Dose,** 4 c.c. (1 fl. dr.).

3. **Glyceritum Ferri, Quininæ et Strychninæ Phosphatum.**—Glycerite of the Phosphates of Iron, Quinine and Strychnine. **Dose,** 1 c.c. (15 ♏).

4. **Syrupus Ferri, Quininæ et Strychninæ Phosphatum.**—Syrup of the Phosphates of Iron, Quinine and Strychnine. **Dose,** 4 c.c. (1 fl. dr.).

5. **ACIDUM ACETICUM.**—Acetic Acid.

Preparation.

Acidum Aceticum Dilutum.—Diluted Acetic Acid. **Dose,** 2 c.c. (30 ♏).

6. **ACIDUM ACETICUM GLACIALE.**—Glacial Acetic Acid.

7. **ACIDUM TRICHLORACETICUM.**—Trichloracetic Acid.

8. **ACIDUM CITRICUM.**—Citric Acid. **Dose,** 0.500 gm. = 500 milligm. (7½ gr.).

Preparations.

1. **Syrupus Acidi Citrici.**—Syrup of Citric Acid.

2. **Liquor Sodii Phosphatis Compositus.**—Compound Solution of Sodium Phosphate. **Dose, 8 c.c. (2 fl. dr.).**

9. **ACIDUM TARTARICUM.**—Tartaric Acid. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

10. **ACIDUM LACTICUM.**—Lactic Acid. **Dose, 2 c.c. (30 ♏).**

ACTION OF SULPHURIC, NITRIC, HYDROCHLORIC, PHOSPHORIC, ACETIC, CITRIC, TARTARIC AND LACTIC ACIDS.

External.—All these acids are powerful local **irritants.** The least so is citric. While its concentrated solution does not affect the sound skin, it is irritant to mucous membranes and abraded surfaces. Next to this comes tartaric, the saturated solution of which acts upon the unabraded skin, and when applied to a raw surface produces more considerable irritation, with pain and heat. The remaining acids are very energetic **caustics,** and even when in very dilute solution cause an irritation which may amount to vesication. The nature of the escharotic action varies to some extent with the constituents of the tissues with which they come in contact, but, on the whole, is found to consist in withdrawal of water, the formation of acid albumins, softening of the connective tissue and epithelium, and, in special situations, solution of calcareous material. The most typical acids in regard to the local action are sulphuric and hydrochloric. Nitric causes the same effects, but differs in its chemical action, by which xanthoproteic acid is produced from the proteids. Owing to the fact that it does not redissolve the albumin it precipitates, its area of action is somewhat limited; but nitrohydrochloric is very energetic. Nitric acid, because of its special chemical action, stains the skin a deep yellow and causes a yellow eschar, while sulphuric, in consequence of its leaving the carbon untouched, blackens the surface and causes a brown or black eschar. The latter acid causes necrosis of the skin and subcutaneous tissues, which is accompanied by intense pain and, if the surface involved is large, by symptoms of shock and collapse such as are met with in severe burns. Ricord's paste is composed of sulphuric acid and willow charcoal; Michel's, of sulphuric acid and asbestos. Hydrochloric acid, though less liable to cause wholesale destruction of the skin than sulphuric, penetrates the epidermis and causes vesication. Phosphoric is considerably less irritant, but causes redness and even blistering when applied in concentrated solution. Glacial acetic acid is especially applicable when a limited action is desired. The corrosive action of the acids is much more intense upon mucous membranes than upon the skin, and even small quantities of strong sulphuric acid striking the eye are sufficient to destroy the sight.

As all the more powerful acids unite with and **coagulate albumin,** solutions of these which are not sufficiently strong to form a slough (which by its separation is likely to cause bleeding) act as **astringents** and **hæmostatics,** both by coagulating the blood, and thus plugging the vessels, and by coagulating the albumin in the tissues, with the effect of constricting the vessels. Weak solutions, moreover, are cooling to the skin in febrile conditions, and hence they are classed also as **refrigerants.** Citric acid is added to tablets of corrosive mercuric chloride so that when these are dissolved in making solutions the antiseptic shall penetrate into the tissues. Tartaric acid is used for the same purpose. As most living matter is neutral or slightly alkaline in reaction, and appears to be incapable of existing in acid media, the acids are protoplasm poisons and antiseptics of some power.

Alimentary Canal.—In the mouth, œsophagus and stomach complete destruction of the mucous membrane results from the corrosive action of strong acids wherever they come in contact with the membrane. As in the case of the caustic alkalies, perforation of the œsophagus or stomach may be produced, causing immediate death, with symptoms of shock and collapse, or if the corrosion does not go to this extent, cicatrices may result which eventually lead to a fatal termination. While hydrochloric and the stronger organic acids are capable of causing corrosion of the mucous membranes, this is not usually so extensive as that produced by sulphuric and nitric acid. In the mouth the diluted acids have a characteristic sour and pungent taste, and, as it is popularly expressed, "set the teeth on edge." They also soften the dental enamel. The saliva being alkaline, they **augment** its **secretion**, and thus serve to allay thirst by keeping the mouth moist. In both the mouth and throat they cause an astringent feeling in consequence of their coagulating the superficial layers of proteids. When the gastric juice is deficient in acid, acids taken after a meal, by remedying this, assist digestion, but it seems to be the case that if given before or during meals they tend to **check** the flow of the **gastric juice.** As the latter, when normal, contains about 0.2 per cent. of hydrochloric acid, this acid, so far as both experimental and clinical results at present indicate, is undoubtedly the best for administration when the amount of acid secreted by the gastric mucous membrane is deficient. Recent researches have shown, however, that pepsin is excreted in actual combination with the hydrochloric acid, so that it would seem to be impossible to completely replace the deficiency of acid in the stomach by giving hydrochloric acid by the mouth. The prolonged treatment of animals with acids has been found to be followed by anæmia and loss of flesh and strength, a result which is thought to be attributable to the disturbance of the digestion induced, rather than to any specific action of the acids. If free acid penetrates into the intestinal canal it acts as a very powerful irritant and produces increased peristalsis, but as acids given by the mouth are usually absorbed before passing the pylorus, this cathartic action is practically seen only when acids are generated in the intestine itself. As a rule, acids quickly become converted into neutral salts, but some, especially sulphuric, preserve, it is said, their **astringent action** in the **intestine.** According to some authorities, the increased flow of pancreatic juice and of bile which has been ascribed to acids is probably too small to be of any value, but others are convinced that they do materially increase the amount of bile poured into the intestine (this being notably the case with nitric acid), while nitrohydrochloric acid is not only a **cholagogue,** but also a **hepatic stimulant** of considerable power, causing actual increase in the activity of the cells of the liver, and not merely evacuation of the gall bladder.

Absorption and Excretion.—Generally the acids are absorbed from the alimentary canal with considerable rapidity. The salts formed in the blood and tissues after their absorption are quickly excreted by the kidneys. The latter, it is found, retain as much alkali as possible in the body, and the result is that they excrete the salts in an acid form, and perhaps some free acid. Consequently, irritation of the kidneys is sometimes induced, with albumin and even blood in the urine, which is rendered more acid than usual and causes a sensation of heat and smarting in the bladder and urethra. Nitric acid, however, is stated to be excreted to a small extent as ammonia, and hence to slightly increase the alkalinity of the urine. The alkalinity of the latter is also increased by acetic, citric and tartaric acids, in consequence of their being converted into alkaline carbonates in the blood; while lactic acid is either so converted or passes out as carbon dioxide in solution in the urine. The acids in general increase the ammonia of the urine (the total nitrogen being pretty constantly increased to a moderate extent) at the expense of the urea, which is accordingly somewhat decreased. Just as the secretion of the acid gastric juice is stimulated by alkalies introduced into the stomach, acids appear to have the power of stimulating alkaline secretions.

Blood.—Acids may have the effect of reducing the alkalinity of the blood, but the reaction of this fluid must necessarily remain slightly alkaline throughout life. It is found that if sufficient acid be given to an animal to neutralize the alkalies of the body, it dies before the blood becomes neutral, although after death the latter may be found to be alkaline. Experimentation has shown that the diminution of the alkalinity of the blood which results from the administration of acids is much more pronounced in herbivorous animals than in man and the carnivora; so that in these last no serious symptoms arise from this cause. In rabbits the blood-pressure is much lowered by the acids, from depression of the vaso-motor centre and the heart, and if the poisoning is pushed, the alkalinity of the blood becomes so greatly reduced that the tissues are unable to rid themselves of their carbon dioxide, and fatal collapse results; the heart continuing to beat for some time after the respiration has ceased. Even in the last stage of intoxication the injection of sodium carbonate, in consequence of the alkali thus supplied to the blood and tissues, will have the effect of bringing about a rapid recovery. It has been found that the red blood-corpuscles are increased in size by the addition of small quantities of acid outside the body, and the amount of phosphates in these cells is believed to be increased by the administration of phosphoric acid. In chlorosis it is stated that the number of the red corpuscles will be increased by hydrochloric acid, though the amount of hæmoglobin remains unaltered.

THERAPEUTICS OF SULPHURIC, NITRIC, HYDROCHLORIC, PHOSPHORIC, ACETIC, CITRIC, TARTARIC AND LACTIC ACIDS.

External.—Owing to their marked affinity for water, it is difficult to limit the local action of sulphuric and phosphoric acids, and consequently nitric acid is much more commonly employed as a caustic. It is the preferred escharotic for venereal sores, warts, poisoned wounds, phagedæna and cancrum oris, and may be advantageously applied in a variety of other conditions, such as uterine ulceration, hæmorrhoids and prolapse of the bowel. In the form of a foot-bath or lotion diluted nitric acid is useful in the treatment of chilblains, and its addition to the bath has been found of service in such skin diseases as impetigo, lepra and acne. Glacial acetic acid is successfully used for warts, corns, ulcers, lupus, epithelioma and nasal hypertrophies, as well as for ringworm and other forms of tinea. If much pain is occasioned it may be more or less diluted. A mixture of 30 parts of acetic acid with 2 parts of salicylic acid is a good application for venereal warts. Hydrochloric acid is sometimes applied to septic wounds, dissecting wounds, and bites of rabid animals, and in combination with pepsin has been utilized for the removal of carious and necrotic bone. The undiluted acid is used to destroy warts on the hands of children, and has been successfully employed as a counter-irritant in sciatica. Three or four coats of it are painted with a small brush along the course of the nerve, after which the part is wrapped up in cotton. The application may be repeated in twenty-four or forty-eight hours, as required. Mixed with an equal proportion of honey it has been used as a topical application in diphtheria, care being taken that it should be confined strictly to the diseased surface. It has also been recommended as an addition to baths in such skin affections as pityriasis and tinea. Lactic acid has been advocated as a solvent of false membrane in diphtheria and croup, though its value in these diseases is somewhat problematical. Equal parts of lactic acid and water may be applied with a brush, and glycerin is sometimes added to the solution. It may also be used as a spray, of the strength of 1 to 8. Lactic acid is employed perhaps more frequently than any other drug as a local application in tuberculosis of the larynx. It is customary to begin with the following: lactic acid 2; water, 1; glycerin, 1; which is applied with a brush. The strength of the solution is then gradually increased until at length the pure acid is used. Lactic acid is also used as a local application for other laryngeal growths, as well as for tubercular ulcerations of the tongue and other accessible parts, and for caries, lupus and epithelioma. For tubercular fistulæ gelatin bougies containing the acid may be resorted to. They are composed of a paste made by gently heating 50 gm. (13 dr.) each of gelatin, lactic acid, and water, and then adding 30 gm. (1 oz.) of menthol; after which the bougies are covered with a coating of collodion. In a 20 to 40 per cent. solution lactic acid has proved of service in the treatment of suppurative otitis and ulcers of the nasal fossa. Any well-diluted acid may be applied to arrest slight bleeding, as from leech-bites, piles, etc. Dilute vinegar will often answer, but sulphuric acid is particularly useful for this purpose, and its astringent effect is also made use of locally in the night-sweats of phthisis. Vinegar, properly diluted, is often employed as a refrigerant for bathing the skin in fever. In chronic cystitis and phosphatic deposits a very weak solution of nitric acid (1 to 480) has been injected with advantage. On account of the intolerance of the bladder, such injections should be permitted to escape immediately.

Internal. *Alimentary Canal.*—In consequence of the injurious effects of acids upon the teeth, it is better that they should be taken through a glass tube. Diluted sulphuric acid is used to a considerable extent as a prophylactic and remedy for lead poisoning, and as a prophylactic measure a lemonade made with sulphuric acid is quite commonly taken by those employed in lead works and paint factories. This treatment is recommended on the ground that the lead taken into the system is by this means changed to the insoluble sulphate and is thus less easily absorbed; but it is a fact that poisoning may be induced by lead sulphate, so that the utility of the measure would seem to be somewhat doubtful. It has been found in practice however, that dilute sulphuric acid is effective in the treatment of lead-colic and that the constipation due to lead is relieved by a combination of sulphuric acid and magnesium sulphate, while the lead-cachexia is much benefited by sulphuric acid given in association with quinine and ferrous sulphate. On the other hand, sulphuric acid is of no service in removing the effects of lead upon the nervous system. Aromatic sulphuric acid, sufficiently diluted with water and syrup, makes a pleasant cooling drink for fever patients. In gastric and intestinal hæmorrhage it acts directly in part, and may therefore prove useful, though its action is sometimes disappointing; and on account of its astringent effect it is often of great value in diarrhœic conditions. A combination of aromatic sulphuric acid with opium is considered one of the most efficient remedies for summer diarrhœa and cholera, and in the treatment of dysentery dilute sulphuric acid may be prescribed with advantage in association with magnesium sulphate and morphine sulphate. Sulphuric acid, being more decidedly astringent, is as a rule, to be preferred to nitric and hydrochloric acids in the treatment of diarrhœa, but the latter are useful also, and the mineral acids as a class are very efficient remedies in summer and colliquative diarrhœa. Whenever the stools are painless, watery, of a light color, and alkaline in reaction, these agents are indicated. Hope's camphor mixture (*see* also p. 276) has long been held in repute in such conditions, but it is said that when made according to the formula now generally in use (Nitric acid, 3; tincture of opium, 1; camphor water, 9) it is not nearly so serviceable as Hope's original formula, in which the acid employed was nitrous acid. Prepared in the original way and used while fresh, the mixture is regarded as a very efficient, though somewhat disagreeable, remedy in serous diarrhœas, as well as chronic dysentery connected with disordered secretion of the liver and other glands of the alimentary canal.

As regards the action on the economy of the three principal mineral acids, the general statement has been made that sulphuric more promotes astringency, nitric, secretion, and hydrochloric, digestion. As previously remarked, hydrochloric acid is the one most appropriate for rectifying a deficiency in acidity in the gastric juice. In dyspepsia due to this cause it is the most valuable remedy which we at present possess, but in many instances the nitrohydrochloric acid is also of great service. For the purpose mentioned these acids have the best effect when taken a little while after eating. A very useful combination consists of nitrohydrochloric acid with tincture of nux vomica and some other stomachic tonic, as the compound tincture of gentian. Hydrochloric acid is sometimes useful, in association with other remedies, in cases of diarrhœa which are characterized by excessive putrefaction of the intestinal contents. As a result of its administration the double sulphates of the urine are in many instances lessened; so that it would seem probable that it has the effect of disinfecting the stomach contents, as the hydrochloric acid of the gastric secretion does normally. In the variety of dyspepsia in which acid eructations, pyrosis, and heartburn occur acids are of decided service, particularly hydrochloric and phosphoric, and they should then be administered before meals. It is said that hydrochloric acid prevents the lactic fermentation in 1 to 1,000 dilution, and that in addition to its action on the digestive ferment it increases the peristalsis of the stomach. Hydrochloric acid is given to a very considerable extent in typhoid fever, where by increasing the secretion of mucus it relieves the dryness of the tongue and fauces, and where it also no doubt tends to disinfect the intestinal contents. In this and other fevers it is believed to be indicated for the reason that the normal secretion of hydrochloric acid is much diminished when the temperature is raised. It may often be advantageously administered in beef-juice. If the diarrhœa is troublesome, sulphuric acid may be given in its place. Hydrochloric acid is sometimes of service also in phthisis; serving to supply to the digestive fluids a material in which they are deficient (both acid and pepsin in the gastric juice being reduced in this disease), and also to disinfect to some extent the alimentary canal. Nitrohydrochloric acid is not, as a rule, so efficient as hydrochloric in ordinary dyspepsia. Still, in many instances it seems to act very satisfactorily, and it is particularly indicated when the biliary function needs stimulating. Its special value is believed to be in hepatic disorders and jaundice. Its mode of action in such conditions is not definitely known, but its peculiar composition may possibly afford some explanation. This acid contains not only nitric and hydrochloric acid, but a number of decomposition products, such as chlorine, nitroxychloride (NOCl), and nitrous acid. The acids, as has been stated, are incapable of acting as such except in the alimentary canal, but it may be that some of the other constituents of this compound, as the chlorine, for instance, have a specific effect on the liver. Duodenitis and catarrh of the gall-ducts accompanied by jaundice and jaundice of malarial origin are among the affections which have been found to be benefited by it, and the experience of physicians practising in tropical countries has been favorable to its use in chronic affections of the liver, as well as in dysentery and dropsy of hepatic origin. In hepatitis the acid is sometimes not only given internally, but applied externally, in the form of a foot-bath or general bath or of a compress placed over the liver. It is scarcely possible, however, to suppose that it can be absorbed in any quantity from the skin; so that any benefit which may be attributable to such external application would seem to be principally due to the counter-irritation caused by it. In acute hepatic diseases and such chronic affections as cirrhosis and waxy degeneration nitrohydrochloric acid is not thought to be of sevice, as a rule, though some authorities advise that it should be tried in the early stages of cirrhosis, while the liver is still enlarged. In some cases apparently of this character great benefit, it is said, has been derived from its use. It is also stated that the wearing around the body of a flannel bandage soaked in a solution of the acid and covered with oiled silk is serviceable in the first stage of cirrhosis, as well as in chronic hepatitis and jaundice.

Phosphoric acid is sometimes used to make cooling draughts in fever, as well as to relieve the thirst in diabetes. Acetic acid in the form of vinegar is a popular remedy for obesity. Its free use, however, is apt to be attended with more or less serious consequences, as it reduces flesh merely by interfering with the digestion. The prolonged administration of large quantities of acids usually proves irritant, and thus, by setting up a certain amount of gastritis, hinders the digestion and absorption of food. In order to allay the thirst of fever patients lemon juice or citric acid itself is used to stimulate the secretion of saliva and keep the mouth moist, and lemonade is a common beverage in febrile diseases. One or the other of these substances thus frequently serves as the basis for cooling drinks, and the acid is largely employed, together with alkaline carbonates, in the preparation of effervescing mixtures which are useful as gastric sedatives. Citric and tartaric acids also form ingredients of various granular effervescent preparations. Lactic acid is only occasionally used in the treatment of dyspepsia, as hydrochloric acid is generally much more satisfactory. At one time, however, under the impression that lactic acid was the normal acid of the gastric digestion, it was quite extensively employed.

Remote Effects.—With the exception of citric, tartaric and acetic acids, the remote effects of the acids are of comparatively little therapeutic importance. Aromatic sulphuric acid was at one time quite largely relied upon for checking profuse sweating, especially the night-sweats of phthisis. It is occasionally so employed with advantage at the present day, but when it is used care should always be taken that it is not allowed to interfere with the digestion. Sulphuric acid was also highly esteemed formerly as a remote hæmostatic, but is not very often used in this capacity now, though some still profess to find it serviceable in certain forms of metrorrhagia. In hæmoptysis it is unquestionably inferior to other remedies. Nitric acid is stated to have been at times used with success in the treatment of intermittent fever, in which, in order to obtain a curative effect, it is insisted that it should be given in full doses every four to six hours. This acid has also been found of service, after the arrest of the paroxysms of intermittent fever by quinine, in removing the hepatic congestion and the changes in the glandular apparatus of the intestines induced by the fever-movement. Chronic bronchitis and hoarseness and the aphonia of singers and public speakers may sometimes be relieved by dilute nitric acid in doses of .60 c.c. (10 ♏). Both nitric and nitrohydrochloric acids have been used, internally as well as in the form of baths, in such diseases of the skin as impetigo, acne and erythema nodosum, while sulphuric acid, also employed internally and locally, is said to be more or less effective in lichen, prurigo, and itching conditions in general. When uric acid is in excess in the urine from faulty digestion and assimilation, nitric acid is often of great service; the excess of uric acid disappearing in consequence of the foods being more adequately prepared for admission into the blood. The mineral acids, and particularly hydrochloric, have been proposed as remedies for acute rheumatism, and tincture of ferric chloride is undoubtedly sometimes of benefit in that disease. Lime juice was formerly a popular remedy in acute rheumatism, but little can be said in its favor. Nitrohydrochloric acid is usually a very efficient remedy in oxaluria, a condition which seems to be dependent upon defective primary assimilation and is characterized by general malaise, a feeling of weakness, great mental depression, a sallow complexion, and often eructations of offensive gas, together with the presence in the urine of crystals of calcium oxalate. It has at times been successfully employed in chronic syphilis. Cases occasionally occur in which, in spite of the administration of mercury and potassium iodide, specific lesions persistently reäppear, particularly in the mouth, and it is in this class of patients that benefit may sometimes be hoped for from the use of nitrohydrochloric acid, although it is in general vastly inferior to both of the remedies mentioned in the treatment of syphilis. Citric, tartaric and acetic acids may be given to increase the alkalinity of the blood and to alkalize the urine or render it less acid. For an effervescent solution of citric acid about 8 parts of the acid may be prescribed along with 7 parts of sodium bicarbonate, with directions to dissolve the two powders separately, mix the solutions, and drink while effervescing. In large quantities this mixture acts as a saline cathartic; in smaller quantities it has the alkalizing effects just stated. There is probably no doubt as to the value of lemon and lime juice in the prophylaxis and treatment of scurvy. This, however, it is stated, is not due to the citric acid, but to some unknown property of the fruit juices. Orange juice has proved completely successful in the cure of infantile scurvy. Lactic, as well as phosphoric acid, has proved useless in the treatment of diabetes, and there is reason to believe that the latter may even be injurious in this disease. Mineral acids, if their administration is too prolonged, tend to impair the appetite and disturb digestion, causing toothache and gastric oppression, and sometimes salivation and diarrhœa. In addition, they are liable to produce loss of flesh, paleness of the skin, and anæmia. If taken for long periods in comparatively large quantities they may induce degenerative changes in such organs as the heart, liver and kidneys, as well as give rise to the production of methæmoglobin in the blood. The prolonged use of nitric acid may occasion erosion of the gums and tongue, with loosening of the teeth.

TOXICOLOGY.

In toxic doses all these acids are severe gastro-intestinal irritants. Tartaric, citric, and lactic acids are very rarely taken as poisons.

Symptoms.—There are intense, burning pains in the mouth, throat, stomach and abdomen, difficulty in swallowing, extreme thirst, and violent vomiting; the ejected matter containing blood and sometimes shreds of mucous membrane. Not infrequently there is diarrhœa, the stools showing a dark discoloration from the presence of blood. Some of the acid is likely to get into the larynx, causing swelling and consequent dyspnœa, from obstruction to respiration. Evidences of shock and collapse quickly develop. The respiration is shallow, the pulse rapid and weak, and the skin, which shows marked pallor, covered with a cold sweat. The temperature falls below normal, and death usually occurs within a few hours. When fuming acids are swallowed, and especially in poisoning with hydrochloric acid, the irritant vapor, passing into the respiratory passages, may cause spasm of the glottis or œdema of the larynx, with the result of an immediately fatal issue from asphyxia. It has been found that as small a proportion of hydrochloric acid vapor as 1 part in 20,000 of air causes sneezing and pain in the throat and chest.

Post-mortem.—There are the characteristic evidences of corrosive poisoning in the mouth, œsophagus and stomach, with or without perforation, and sometimes extending into the intestine. The sloughs resulting from the destruction of the mucous membrane are of a whitish-gray color, and hæmorrhages are frequently met with. When death has been delayed for some time fatty degeneration of the heart, muscles, liver or kidney may be found, and in these cases a form of necrosis of the renal cells has sometimes been observed.

Treatment.—Alkalies should be given at once to neutralize the acid, though there is a possibility that the stomach may be ruptured by the carbon dioxide gas generated from the combination thus formed. The best antidote is the insoluble magnesium oxide or carbonate, because these are not themselves corrosive, but if neither is procurable, almost any accessible alkali may be resorted to, such as lime, chalk, soap or wood ashes. Then demulcents may be given, such as milk, white of egg, oil and flaxseed tea, which are useful in protecting the walls of the œsophagus and stomach; and the acid may be rendered less corrosive by diluting it with large quantities. If strong sulphuric or nitric acid has been swallowed, the stomach-tube should not be employed, on account of the danger of its extremity passing through the softened walls of the gullet or stomach; otherwise the stomach should be washed out. Morphine may be injected hypodermatically to relieve pain, and brandy or other stimulants used in the same way to counteract collapse.

CHROMIUM SALTS.

1. **CHROMII TRIOXIDUM.**—Chromium Trioxide. (Chromic Acid. Chromic Anhydride.)

2. **POTASSII DICHROMAS.**—Potassium Dichromate. **Dose, 0.010 gm. = 10 milligm. (⅕ gr.).**

ACTION OF CHROMIUM TRIOXIDE.

External.—Chromium trioxide is a **powerful caustic.** By reason of its oxidizing power it is also an energetic deodorant and disinfectant. When applied in substance it corrodes the skin, as well as other tissues, but it causes much less pain than the more penetrating caustic potash. Even in dilute solution it is an irritant to the skin, producing ulcerations and other lesions, and workmen in factories where chromic acid is used are liable to suffer from perforation of the nasal septum from the local action of the acid applied accidentally upon the fingers.

Internal.—The symptoms produced by large quantities are those of gastro-intestinal corrosion, intense pain in the throat and stomach, vomiting and purging, with blood in the vomited matter and the stools, collapse, and frequently death. Post-mortem the lesions met with are those of corrosive poisoning, and the mouth and throat show a characteristic yellow discoloration. In mammals the administration of the drug elicits effects similar to those produced by the metals in general. Weakness and slowness in the movements are caused, and these are followed by albuminuria, and later by diarrhœa and vomiting. Sometimes twitching of the muscles or even convulsions are observed, and then the weakness passes into general paralysis. The heart appears to be little affected, but the blood-pressure falls. After death the stomach and intestine are found congested, while the mucous membrane is necrosed and ulcerated in some parts and covered with ecchymoses in others. Hæmorrhages are also found in other organs, and particularly in the cardiac wall, and parenchymatous nephritis is met with. In chronic poisoning interstitial nephritis is said to occur. Chromium trioxide is readily absorbed from the stomach and intestine. It appears to be excreted principally through the kidney, and to a less extent through the intestinal epithelium.

THERAPEUTICS OF CHROMIUM TRIOXIDE.

External.—Chromium trioxide is never employed internally. A lotion of the strength of 1 per cent. is used in Germany to toughen the feet of marching soldiers. On account of its disinfectant properties it is employed in the form of a lotion, 1 to 40, or even stronger, for cleansing foul ulcers and sores and as a local application, in various dilutions, in gonorrhœa, leucorrhœa, ozæna, severe ulcerations of the mouth, etc. It is also sometimes used as a gargle, and for this purpose the solution should not be stronger than 1 to 480. A Liquor which is one part of chromic acid in 3 of water, may be employed as a caustic to destroy condylomata and other small growths. As the escharotic action tends to spread, it should be used with caution. Thus, the adjacent surface should be protected with ointment, and the excess of acid promptly removed with an alkaline wash. A solution of chromium trioxide of the strength of 1 to 48, applied once or twice a day, is an excellent remedy for enlarged tonsils and syphilitic mucous patches. It has also been used in endocervicitis, uterine hæmorrhage, hypertrophies of the nasal passages, and some malignant growths, and has been injected into hæmorrhoids. For parasitic skin diseases, such as sycosis, lupus and tinea circinata, a solution ten times the strength of this may be employed. A 3 per cent. ointment is serviceable in favus, after the crusts have been removed, and a wash of the strength of 1 to 250 of water, and also containing tannic acid, hydrated chloral, and morphine sulphate, has been recommended for chronic ulcers. A 1 per cent. solution in water, it is stated, has been found valuable in cases of viper bites. The following treatment has proved successful in ranula and cystic goitre: The tumors are opened and their contents washed out, and, after hæmorrhage has ceased, a saturated solution of chromium trioxide is freely applied to several points of the cyst wall.

Action of Potassium Dichromate.

External.—Like chromium trioxide, it is an **irritant caustic.** Its escharotic, as well its antiseptic, action, however, is somewhat less energetic than that of the trioxide; though the workmen engaged in making it are liable to painful ulcerations of the hands. Eczema of the hands, moreover, is said to occur in those who prepare the dichromate solution used for dyeing purposes, and material dyed with the latter may produce ulceration of the integment.

Internal.—The effects are essentially the same as those of chromium trioxide, and if the quantity swallowed is sufficiently large, death may result. Less than 30 gm. (1 oz.) has caused unconsciousness in five minutes, with death thirty-five minutes later. In two recorded fatal cases of poisoning by it the amounts taken were respectively 8 and 15 gm. (2 and 4 dr.). In doses of 0.05 gm. (3/4 gr.) it acts as an emetic.

THERAPEUTICS OF POTASSIUM DICHROMATE.

External.—It is used as a caustic for warts, venereal ulcers, and mucous patches. Its solution has also been employed as a disinfectant wash for sloughing wounds.

Internal.—It has been recommended for the treatment of gastric catarrh and gastric ulcer in dose of from .005 to .01 gm. ($\frac{1}{12}$ to $\frac{1}{6}$ gr.), given thrice daily on an empty stomach, and is reputed to relieve nausea, vomiting and pain. In catarrhal conditions of the respiratory tract it has been advocated as an expectorant. It has been employed successfully in children, in small doses (0.003 gm.; $\frac{1}{20}$ gr. for an infant of one year), every hour, and it is advised that when the respiration is seriously embarrassed, the dose should be repeated every fifteen to thirty minutes. Favorable results have been reported from its use in cases of hæmatochyluria, some of which depended on the presence of filariæ, and it has been recommended for the treatment of pernicious malarial anæmia. It has also been employed in syphilis and chronic rheumatism, but without any appreciable results. In cases of poisoning by chromium trioxide or potassium dichromate, soap, an alkaline carbonate, or magnesia, together with milk, may be given at once, and the stomach washed out.

TURPENTINE.

1. **TEREBINTHINA.**—Turpentine.

Preparation.

Ceratum Resinæ Compositum.—Compound Rosin Cerate.

2. **OLEUM TEREBINTHINÆ.**—Oil of Turpentine.

Preparations.

1. **Emulsum Olei Terebinthinæ.**—Emulsion of Oil of Turpentine. **Dose, 4 c.c. (1 fl. dr.).**

2. **Linimentum Terebinthinæ.**—Turpentine Liniment.

3. **Oleum Terebinthinæ Rectificatum.**—Rectified Oil of Turpentine. **Dose, 1 c.c. (15 ♏).**

ACTION OF TURPENTINE.

External.—Oil of turpentine has the characteristic action of the volatile oils in general. On the skin it acts as a **rubefacient irritant, and counter-irritant,** and its prolonged application may give rise to vesication or even ulceration. The effects are more marked if it is applied with friction. Under its external use, then, we find produced tingling, a feeling of warmth, and reddening of the surface, all of which result from the local dilation of blood-vessels caused by it. On mucous membranes there is found the same irritation, with redness and congestion, pain and smarting. Applied to fresh wounds, it is hæmostatic, contracting the blood-vessels and aiding coagulation. Oil of turpentine is a fairly energetic antiseptic, and it is less irritant than many of the more powerful ones. It is absorbed from the unbroken skin.

Internal. *Alimentary Canal.*—Kept in the mouth, it causes the same redness and irritation of the mucous membrane, and is apt to excite a reflex secretion of saliva. In the stomach it gives rise to a feeling of **warmth** and comfort and causes some **reflex stimulation** of the heart. It also acts as a **carminative,** accelerating peristalsis and promoting the expulsion of gas. Whether the volatile oil has any direct action on the gastric secretion is still a disputed point. It has been recently shown that from the intestine, as well as the stomach, absorption occurs more rapidly in the presence of slight irritants. It is still unknown whether the peristaltic movements of the bowel are increased by it, though turpentine certainly appears to have a marked stimulating effect upon the muscular coat of the intestine. It diminishes flatulence and distention, and its antiseptic action may be concerned in the production of this result. It is **anthelmintic,** and in sufficiently large doses **cathartic,** the fæces often containing blood.

Circulation.—Our knowledge of its action on the circulation is very imperfect, and the statements of various observers regarding this differ greatly. It appears to produce a very slight rise of arterial pressure, increased pulse-rate, and **increased cardiac force.** The drug is known to have **hæmostatic** properties, and this action is no doubt due to its power of contracting the vessels. After a large dose the stimulation is followed by depression, the action of the heart growing feeble, the blood-pressure falling, and the vessels dilating.

Nervous System.—In its action on the nerve cells oil of turpentine differs from some of the other volatile oils in that the preliminary stimulation caused by large amounts is only transitory, being quickly followed by marked weakness and depression; with heaviness, unsteady gait, and drowsiness. Toxic doses are said to cause paralysis of sensory nerves, loss of reflex action, insensibility and coma. The depression of the respiratory centre in the medulla is preceded by stimulation, the breathing increasing in rapidity and volume.

Respiration.—Oil of turpentine is in part excreted by the bronchial mucous membrane, and during the course of this excretion it exerts an irritant action on the respiratory passages which may be sufficient to lead to bronchitis. Such excretion may be at once **stimulating** and **antiseptic**, and turpentine may also diminish the bronchial secretion in a specific manner. According to some authors it acts as an expectorant, while others consider that it diminishes excessive secretion and allays cough. It has consequently been suggested that both statements may be true in different pathological conditions and with different doses of the drug. When **inhaled**, the vapor of turpentine has an **irritating** effect on the bronchial mucous membrane, just as the oil does when applied directly to mucous membranes and to the skin. The disinfecting agency of the drug is shown by the fact that turpentine prevents experimental tuberculosis in dogs.

Kidneys.—It is largely excreted by the kidneys. Its action upon these organs is more energetic than that of almost any other volatile oil, and especially results in **diuresis**. Large doses are very irritant, lessening the amount of urine, rendering it highly colored, and in some cases producing **albuminuria**, **hæmaturia**, and even total suppression. This irritant action is not confined to the kidneys, but extends to the whole genito-urinary tract. There is much aching in the loins, with spasmodic pain in the ureters, a sensation of heat in the perineum, a constant desire to pass water, without the ability to do so, in consequence of the urethral spasm, and a general condition of **strangury.** Priapism may be induced, and an intolerable irritation may affect all the pelvic organs. In especially susceptible individuals symptoms of this character may be caused by even moderate amounts of the drug. A characteristic effect of turpentine is the odor of violets which it imparts to the urine.

Skin.—There is reason to believe that it is excreted to some extent by the skin glands. In persons with an idiosyncrasy to turpentine, erythematous, papular or vesicular eruptions may be caused by both its internal and external use.

It seems probable that oil of turpentine is excreted in part by the intestine and in the bile, milk, and other secretions.

Temperature.—It appears to have a slight antipyretic action.

Old oil of turpentine, containing oxygen, is an antidote to phosphorus (*see* phosphorus). The statement has been made that this and the French oil are preferable in other respects; but this seems questionable.

THERAPEUTICS OF TURPENTINE.

External.—Oil of turpentine is highly esteemed as a counter-irritant in bronchitis, pneumonia, pleurisy, peritonitis, osteo-arthritis, and other inflammatory conditions, and in such painful disorders as pleurodynia, neuralgia, myalgia, lumbago and old rheumatic pains. It is often employed in the form of a stupe, which consists of a piece of flannel heated by steam or by being wrung out of hot water, on the surface of which a few drops of turpentine are sprinkled just before application. Turpentine stupes should be removed as soon as they cause pain. Spongiopiline may be used in place of the flannel. A mixture of equal parts of turpentine and yolk of egg is sometimes employed for external applications. In peritonitis a combination of oil of turpentine with olive oil and mercurial ointment, applied warm upon flannel over the abdomen, has been used with advantage. The external application of oil of turpentine is also sometimes of service in puerperal fever. When friction is desired, as in the case of rheumatic joints, it is advisable to use turpentine in the form of a liniment, in which it is often associated with other substances. The official liniment, for most purposes, should be diluted. Preparations containing turpentine are sometimes employed for topical application in inflammatory affections of the pharynx, tonsils and larynx, and in diphtheria the oil has been brushed on the affected parts or used by inhalation. In this disease it is stated that advantage has been derived from the continuous inhalation of a mixture composed of one part each of phenol and oil of eucalyptus and 8 parts of oil of turpentine; cloths saturated in the fluid being hung or laid near the face of the patient, but not allowed to come in contact with the skin. Oil of turpentine has been used with success in the treatment of severe burns, accompanied by constitutional depression, and it is an excellent antiseptic for old suppurating wounds. Care must be taken that it does not blister the skin. It is sometimes used as a parasiticide for ringworm, and an ointment of turpentine (soft soap, 3; distilled water, 10; camphor, 2; oil of turpentine, 23), is said to be advantageous in chronic eczema, psoriasis and alopecia circumscripta, as well as a good application for indolent ulcers.

Internal. *Stomach and Intestines.*—For internal use the rectified oil only should be prescribed. It is not very frequently employed as a stomachic, but is used to a considerable extent as an intestinal carminative; and flatulence may often be promptly relieved by a few drops on a lump of sugar. It is regarded as especially indicated in persistent flatulence resulting from a paretic condition of the muscular coat, and it has been shown to possess curative power in chronic intestinal catarrh. Among the indications for its administration may be mentioned a dry and glazed tongue, tympanitic distention of the abdomen, and stools which are either fluid or consist of scybala mixed with mucus and pale, watery blood. It is thus a valuable remedy in subacute dysentery, where it is often given in an emulsion with almond oil and opium. In these cases it is believed that it gives tonicity to the vessels and to the muscular fibres of the intestines, arrests the putrefactive and fermentative processes which take place in the vitiated mucus and articles of food, and by increasing the cutaneous capillary circulation relieves congestion of internal organs. From our knowledge of the physiological effects of oil of turpentine it would naturally be supposed that it might prove of service in typhoid fever, both as a hæmostatic and an antiseptic, and in many cases of this disease it is found to be of the greatest practical value. Here it not only acts as a local stimulant to the ulcerated bowel, but also exerts a beneficial influence upon the general state of the system. Two conditions or stages in the disease have been pointed out in which it is especially useful. The first is when at about the end of the second week the tongue becomes very dry, red, chapped, and perhaps coated in the centre with a brownish fur, and at the same time marked meteorism develops. 0.6 c.c. (10 ♏) of the oil of turpentine, given every two hours during the day and every three hours in the night, will be found in many instances to do away with these unfavorable signs. The second is when the ulceration of Peyer's patches proves slow to heal, so that there is a constant tendency to the recurrence of diarrhœa, and convalescence is thus delayed. Here the remedy seems to act almost as a specific. It is stated that the typhoid fever bacillus will not develop in air containing diluted vapor of turpentine, and dies when the air is saturated with the vapor, while thymol appears to be even more efficient than turpentine. The intestinal hæmorrhage of typhoid may also often be successfully treated with oil of turpentine. Administered in the form of an enema, in some such vehicle as mucilage of starch, it is very effective in relieving flatulence of the bowels, and where there is impaction of the cæcum or rectum castor oil is frequently combined with it in the injection. Turpentine has also been used by enema as a derivative in insolation or sunstroke and in cerebro-spinal meningitis, as well as a remedy for thread-worms. Given internally, oil of turpentine is efficacious in the treatment of tape-worm, but as the dose required for this purpose is large, it may produce strangury and other constitutional effects. For this reason castor oil or other purgative should be promptly administered after it, and many advise that the purgative should be combined with it. A combination of equal parts of turpentine and ether (Durand's remedy) at one time acquired considerable reputation in the treatment of biliary calculi. While during the acute attack of biliary colic it is inferior to other remedies, as morphine and hydrated chloral, clinical experience seems to have shown that in the after-treatment its occasional administration may sometimes be of service as an adjuvant to other measures. In yellow fever, puerperal septicæmia, and other febrile diseases, as well as in typhoid, oil of turpentine has been successfully employed as a stimulant and antiseptic. In affections of this class it is recommended that for the intestinal complications the dose, as a rule, should be small and frequently repeated, while as a stimulant to the vaso-motor nervous system it should be somewhat larger and repeated at somewhat longer intervals.

Circulation.—It is contra-indicated where there is active hæmorrhage and a condition of plethora, in hypertrophy of the heart, and when advanced atheroma of the cerebral arteries is believed to be present. In the passive hæmorrhages in ataxic cases, where there is a condition of debility, relaxation of the vessels, and an impoverished condition of the blood, it is of great service. It may be given in hæmorrhages from the stomach, bowels, lungs, etc., and is also efficacious in the hæmorrhagic transudations met with in purpura, scurvy, and allied states.

Respiration.—For the purpose of inhalation turpentine may generally be replaced with advantage by the Oleum Pini (*see* p. 326), especially as the latter is much more agreeable, but it is occasionally used internally in chronic bronchitis with profuse expectoration (especially when the latter has a fetid odor), and in gangrene of the lung. It may also be employed in pneumonia and capillary bronchitis with marked depression of the vital powers and enfeeblement of the circulation, and particularly when these affections occur in the course of typhus or typhoid fever and similar diseases. Here it is often applied externally, as well as given by the mouth.

Genito-urinary Tract.—Turpentine would no doubt be more generally employed than it is in a variety of affections (as it unquestionably has a considerable number of useful applications), were it not that it is so disagreeable to take, and also because of the fact that it is so liable to cause inflammation of the kidneys. On the latter account it must always be administered with caution, and it is, of course, entirely contra-indicated when renal disease is present. An exception as regards the latter, however, is sometimes made in the case of chronic pyelitis, where the oil of turpentine, as well as those of copaiba and cubeb, may have a good effect in changing the condition of the mucous membrane and limiting the formation of pus; also in hydro- and pyo-nephrosis, where by actual contact it may alter the relaxed state of the vessels and the pathological secretions of the mucous membrane. In these conditions it should always be given in small doses and its effects watched with extreme care. In incontinence of urine, due to atony of the muscular coat of the bladder and not to spasm, and in chronic cystitis, gleet, spermatorrhœa and prostatorrhœa, when the discharges characterizing these affections are the result of relaxed conditions, turpentine, in moderate doses, may not infrequently be administered with considerable benefit. In all these cases it should be borne in mind that, with the exception of cantharides, oil of turpentine is the most actively stimulating of all the diuretics, so that it must be resorted to only when a stimulant effect is called for. It is never employed to increase the flow of urine for the purpose of affecting serous effusions, being used as a diuretic simply for its local influence upon the kidneys. Excessive diuresis sometimes is apparently dependent upon a relaxed condition of these organs, and under these circumstances oil of turpentine may be of service.

CANADA TURPENTINE.

TEREBINTHINA CANADENSIS.—Canada Turpentine. (Canada Balsam. Balsam of Fir.)

ACTION OF CANADA TURPENTINE.

Its action is the same as that of oil of turpentine.

THERAPEUTICS OF CANADA TURPENTINE.

Under the names of Canada balsam and balsam of fir, as well as the deceptive title of "balm of Gilead," Canada turpentine has been used to a considerable extent, especially in the treatment of chronic bronchitis. It is principally employed (in consequence of its physical property of drying), for forming an adhesive varnish.

FIR-WOOD OIL.

Oleum Pini.—Oil of Pine (unofficial). (Fir-wood Oil. Pinol.)

ACTION OF FIR-WOOD OIL.

The action of oil of pine is the same as that of oil of turpentine.

THERAPEUTICS OF FIR-WOOD OIL.

This oil is used locally or by inhalation. It is much more agreeable than the oil of turpentine, and is employed in various sprays and inhalations in the treatment of acute coryza, nasal catarrh and many diseases of the respiratory passages. It is especially useful as a stimulating, disinfectant expectorant inhalation in chronic bronchitis or laryngitis.

OIL OF ERIGERON.

OLEUM ERIGERONTIS.—Oil of Erigeron. (Oil of Fleabane.) Dose, 1 c.c. (15 ♏).

ACTION OF THE OIL OF ERIGERON.

It has the same general effects as oil of turpentine, but is less irritant.

THERAPEUTICS OF THE OIL OF ERIGERON.

While it is less irritant, it is also less efficient than oil of turpentine. Externally it is often applied to prevent insects from injuring the skin. It has been used in diarrhœa, dysentery and hæmorrhages, in much the same way as oil of turpentine. It has the advantage over the latter of being much less unpleasant to take, and has been found by some an effective remedy in hæmoptysis, as well as in menorrhagia and in metrorrhagia, when of passive character. In acute congestion of the kidneys it is contra-indicated, but in the strictly chronic forms of renal disease it is thought to lessen the albumin, and at the same time to improve the general condition of the patient.

TAR.

PIX LIQUIDA.—Tar. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Syrupus Picis Liquidæ.**—Syrup of Tar. **Dose, 4 c.c. (1 fl. dr.).**
2. **Unguentum Picis Liquidæ.**

OLEUM PICIS LIQUIDÆ.—Oil of Tar. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF TAR.

External.—Though its effects are somewhat less pronounced, tar is, like oil of turpentine, a **local irritant,** by reason of its action in dilating the blood-vessels. If its application is prolonged, it is likely to induce an eruption of red papules, some of which may suppurate, constituting what is known as "tar acne." This is sometimes met with in those who work in tar or are much exposed to its fumes. When it is applied over a large area, absorption from the skin may give rise to toxic symptoms resembling those of phenol poisoning. In less concentrated form it relieves itching, an effect which has been attributed to its reducing the sensibility of the sensory nerve terminations. The vapor, when inhaled, has a local **antiseptic** and **stimulant** action on the **respiratory mucous membrane.** Tar has very valuable antiseptic and **disinfectant** properties, and on account of its cheapness it is especially serviceable for the disinfection of excrementa, premises, etc.

Internal.—In small doses it has the effect of stimulating the circulation and increasing the secretions. It is excreted by the respiratory mucous membrane and the kidneys, and acts as a stimulant and antiseptic during elimination. It is thus both a **diuretic** and **expectorant.** In large doses it produces headache, epigastric and abdominal pain, general malaise, indigestion, vomiting of dark-colored matter, loose black stools, and blackish-brown urine, which smells of tar and may contain blood or albumin. The urine may possibly be clear when passed, but on standing it throws down a dark deposit. The symptoms, it will be seen, have considerable resemblance to those of phenol poisoning.

THERAPEUTICS OF TAR.

External.—Wood tar is the only official form of tar, but coal tar is often used in medicine. The prepared form of it is made by simply heating and stirring coal tar at 120° F. (48° C.) for an hour. The chief use of tar is for the local treatment of certain forms of skin disease, and for this purpose it is applied in lotions, paints, ointments, plasters, soaps and baths. The official ointment is liable to cause more or less irritation, and should generally be diluted. In order to prepare an unirritating tar ointment, it has been advised that the tar be previously allowed to stand for several weeks in a warm place. It will be found that it separates into two layers, the upper of which is thin and syrupy, and is destitute of irritant properties. Liquor Picis Carbonis (not official) is a favorite preparation for many skin diseases. It may be made thus: Dissolve rosin soap (*see* Rosin), 1, in alcohol, 8; add prepared coal tar, 4; digest at 125° F. (51° C.) for two days, allow it to cool, then decant and filter. An ointment of 3 parts of lard with 1 of this solution may be made. Liquor Picis Carbonis Detergens (not official) is an alcoholic solution of ordinary coal tar, which is used externally in skin diseases, diluted in 20 parts of water. Tar is especially useful in scaly affections, such as psoriasis. Among the other skin diseases in which it is serviceable may be mentioned lichen, chronic eczema, comedo, sycosis, pemphigus, prurigo, and lupus erythematosus and vulgaris, as well as scabies and tinea. An alkaline tar-water, made by adding tar, 2, and caustic potash, 1, to water, 40, is a good application in eczema. A diluted tar ointment, by reason of its mildly anæsthetic action, is useful in relieving pruritus ani and other itching affections. The tar-water which was formerly official (made by mixing 1 part of tar with 4 of water) is an efficient antiseptic application to unhealthy wounds or sores. This preparation used with an atomizer or vaporized by heat is beneficial in acute pharyngitis and laryngitis, as well as in chronic catarrhal affections of the air-passages. It has been found of service in winter cough, and is said to materially lessen the tendency to taking cold. Sufferers from chronic bronchitis sometimes derive considerable benefit from the fumes given off from tar which is allowed to simmer in a vessel placed on a stove in the room occupied by them. In ozæna the inhalation of the fumes of a mixture containing tar, camphor, potassium iodide, and tincture of iodine, placed upon a water-bath, has been recommended. In the treatment of hæmorrhoids the application of a preparation consisting of tar, 3, extract of belladonna leaves, 3, and glycerite of starch, 30, has been found useful. In some individuals there is an intolerance of tar, so that even the smallest quantity will be found to excite irritation and cause a papular, eczematous eruption.

Internal.—Except as a remedy for some chronic diseases of the skin, tar is used internally almost exclusively as an expectorant. Wood tar only is given for bronchial affections, and it is in the chronic forms of these that it proves especially valuable. It may be prescribed in pill, as the syrup, or as the French preparation, Eau de Goudron. Vinum Picis Liquidæ (not official), which is a saturated solution of tar in sherry wine and the dose of which is 4 to 15 c.c. (1 to 4 fl. dr.), is used to a considerable extent. An excellent cough mixture consists of the syrups of tar and wild cherry, with .003 gm. ($\frac{1}{20}$ gr.) of apomorphine hydrochloride in each dose. The dose of tar-water is 500 c.c. (1 pint) daily. The latter has been found of service in some cases of chronic pulmonary tuberculosis; quieting cough, checking diarrhœa, and improving the appetite and digestion. In chronic diseases of the skin the internal administration of wood tar is sometimes a valuable adjunct to local treatment, and the action of small doses has been found especially favorable in psoriasis and eczema. Tar has also occasionally been given internally in hæmorrhoids and in catarrh of the urinary tract.

OIL OF CADE.

OLEUM CADINUM.—Oil of Cade. (Juniper Tar Oil.)

ACTION OF OIL OF CADE.

It has much the same action on the skin as tar, but its preparations have decidedly less odor and are less injurious to the clothing.

THERAPEUTICS OF OIL OF CADE.

Oil of cade is too stimulating for most acute eruptions, but is used with benefit in chronic eczema, psoriasis, pityriasis rubra, lichen, prurigo, and various forms of pruritus. It is also an efficient parasiticide in favus and other varieties of tinea. It is sometimes applied in full strength and sometimes diluted with a bland oil, and is also made into ointments, and especially into soaps. A common formula consists of oil of cade, 1; soft soap, 4; alcohol, 4. An ointment made by melting with it an equal part of yellow wax is a stronger and also a more agreeable preparation. A mixture of oil of cade in acetone collodion has been recommended as having special advantages in psoriasis, lichenoid eczema, simple chronic lichen, lichen planus, and in nummular and seborrhœic eczemas. "Haarlem oil," which is said to be composed of equal parts of oil of cade and oil of juniper berries, has had a considerable vogue in chronic affections of the kidneys and bladder. As an anthelmintic oil of cade has been given in doses of .15 to .30 gm. (3 to 6 ♏), repeated several times a day.

ROSIN.

RESINA.—Rosin. (Resin. Colophony.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Ceratum Resinæ.**—Rosin Cerate. (Basilicon Ointment.)
2. **Ceratum Resinæ Compositum.**—Compound Rosin Cerate.

ACTION OF RESIN.

Locally rosin is antiseptic and slightly irritating; internally it is **antiseptic** and **astringent** in its effects upon the intestines. It has the property of preventing the oxidization of fatty substances, and thus contributes to the preservation of ointments.

THERAPEUTICS OF ROSIN.

Rosin cerate is a good dressing for indolent or unhealthy ulcers and wounds, promoting cicatrization and granulation, as well as acting as a disinfectant. It is also sometimes applied to burns and chilblains. Compound rosin cerate (Deshler's salve) is more stimulating, as it contains crude turpentine. The chief use of rosin is in plasters, which it renders adhesive and more or less stimulating. In chronic bronchitis and winter cough the fumes from boiling rosin may sometimes be inhaled with advantage. Rosin was at one time employed in diarrhœal affections, in which it had some vogue as a domestic remedy, but is now seldom given internally.

MUSTARD.

1. **SINAPIS ALBA.**—White Mustard. **Dose** (emetic), 8 **gm.** (120 **gr.**).

2. **SINAPIS NIGRA.**—Black Mustard. **Dose** (emetic), 8 **gm.** (120 **gr.**).

Preparation.

Charta Sinapis.—Mustard Paper.

3. **OLEUM SINAPIS VOLATILE.**—Volatile Oil of Mustard. **Dose, 0.008 c.c. (1/8 ♏).**

ACTION OF MUSTARD.

External.—Oil of mustard differs from the other volatile oils in that it produces a markedly greater irritation. Being extremely diffusible, it has a very **deep action,** without producing very profound destruction of the surface. Locally applied, mustard is a **rubefacient, counter-irritant,** and nervous stimulant, causing heat, redness, and severe burning pain. These effects are produced by its action in dilating the blood-vessels and irritating the sensory nerves. The **stimulation** of the latter is **followed** by their **paralysis,** in consequence of which there results a local **loss of sensibility**. If the application is sufficiently prolonged, it induces **vesication,** the irritation of the vessels leading to the transudation of plasma, which raises the epidermis and thus forms vesicles or blisters. The blistering caused by it is more painful and heals less rapidly than that of cantharides, which is no doubt due to the fact that the oil of mustard penetrates more deeply into the tissues and thus sets up more extensive inflammation. When the crude drug, moistened, is applied to the skin, the oil is found to form only slowly, so that the action of the irritant becomes continuously more intense. The excitation of the sensory nerves caused by the external application of mustard is sufficiently powerful to induce more or less reflex stimulation of the heart and respiration, and sometimes to restore consciousness to those suffering from syncope.

Internal. *Gastro-intestinal Tract.*—Mustard is also a powerful **irritant** to the alimentary canal. In small amounts it is taken as a condiment and stimulates the appetite. It has generally been supposed to increase the secretion of gastric juice, but this is said not to be the case. Large doses irritate the stomach and produce prompt vomiting, which, in consequence of the **reflex stimulation** of the **heart** and **respiration** caused by the drug, is not attended with the depression usually resulting from emetics. The emetic effect is increased by giving the mustard in a considerable quantity of lukewarm water. The oil of mustard is an energetic irritant, a single drop upon the tongue producing an intense burning pain in the nose, throat and stomach.

General Action.—Upon the organs and tissues mustard, in ordinary doses, has very little appreciable effect, but very large doses of the oil prove fatal to rabbits. The action of the heart is at first increased and then diminished, the respiration becomes impeded, insensibility follows, and a fall of surface temperature precedes death. Post mortem there is found redness, but only slight inflammation, of the gastro-intestinal tract, with destruction of the epithelium. The kidneys are also hyperæmic, and the blood is said to smell of mustard.

THERAPEUTICS OF MUSTARD.

External.—A mustard plaster or sinapism is a very useful means of relieving gastralgia, neuralgia, pain in chest affections, lumbago, and a great variety of other conditions. While the application itself may be temporarily painful, the secondary effect, both as to the pain due to the mustard and that from the condition present, is soothing, in consequence of the loss of sensibility resulting from the paralysis of the sensory nerves produced by the drug. Sinapisms are prepared by mixing mustard (to which an equal quantity of flour is usually added to render the effect less severe), with warm water to a smooth paste, which is spread upon linen. A layer of muslin or thin unglazed paper is usually placed between the mustard and the skin. As a rule, they are best applied a little distance from the seat of pain. Thus, to relieve headache they are most serviceable when placed at the nape of the neck. Sinapisms are also applied to the epigastrium in persistent vomiting, to the loins in suppression of urine, to the præcordial region in threatened syncope, and to the calves of the legs and other parts of the body in narcotic poisoning, asphyxia or syncope. In the latter conditions the object is, of course, to stimulate the nervous system, but in all cases of insensibility care should be taken that the application is not continued too long, on account of the danger of causing vesication or even more serious local trouble. In the case of children the proportion of mustard employed should not exceed one-fourth. The mustard leaves and papers sold in the shops are very convenient for ready use. They are generally very strong, however, and one or two layers of moistened linen should be placed between the sinapism and the skin to prevent too great an action. In the official paper a surface of 60 square c.c. contains about 4 gm. of black mustard deprived of oil. One advantage which mustard possesses for the purpose of revulsion is the readiness with which its action may be controlled by the regulation of the strength of the application and the time which it is allowed to remain. In many cases it is desirable to maintain for hours a mild, equable counter-irritant impression, and this may be done by adding about one-sixteenth part of mustard to a flaxseed poultice. In bronchitis, pleurisy or pneumonia a "jacket poultice" is often applied to the chest, and the larger the poultice the more pronounced is the effect upon the internal organs. Large mustard poultices are also used with advantage in acute inflammations of the abdominal viscera. When it is desired to dilate the peripheral vessels over a large area, in order to withdraw blood from internal parts and thus produce a "derivative effect," a hot bath to which mustard is added (1 to 128) is often serviceable. A general mustard bath [illegible] children in the early stages of febrile [illegible]. In older persons a hot mustard foot-[illegible] (enough to reach nearly to the knees) is useful for [illegible] common colds and various febrile con-[illegible] mustard sitz-bath is commonly employed, just [illegible] period, to induce menstruation. In place [illegible] foot-bath is sometimes used for this pur-[illegible] relieve the congestive headaches, hot flush-[illegible] symptoms often met with at the time of the [illegible]

[illegible] of lukewarm water, with the addi-[illegible] gm. (1 to 4 teaspoonfuls) of mustard is in [illegible] an emetic, and is especially advantageous in [illegible] poisoning by reason of the reflex stimulation [illegible] mustard. Otherwise the drug is not very often [illegible], except as a condiment, though it may [illegible] of service. White mustard seeds have some [illegible] as an emmenagogue, and obstinate hiccough is said [illegible] relieved by an infusion of mustard, 1 to 30 of [illegible]

OIL OF CAJUPUT.

[illegible] CAJUPUTI. Oil of Cajuput. **Dose, 0.5 c.c. (8 ♏).**

ACTION OF OIL OF CAJUPUT.

[illegible] of oil of cajuput, externally and internally, is [illegible] antiparasitic. Externally it is rubefacient and [illegible] upon the subsidence of the hyperæmia, it is [illegible]

THERAPEUTICS OF OIL OF CAJUPUT.

[illegible] Being a strong, stimulating **rubefacient** and **irri-[illegible]** rubbed into the skin usually diluted with olive oil— [illegible] variety of conditions such as muscular rheumatism, [illegible] headaches, and chronic inflammatory affections of [illegible] and periosteum, as well as in such cutaneous [illegible] as chronic eczema, psoriasis and rosacea. In alopecia [illegible] as an ingredient of various stimulating ointments.

On account of its parasiticidal properties it is also of service in the treatment of tinea, scabies, etc. Like many other oils of its class, it will relieve toothache if introduced into the hollow of the carious tooth. To some individuals its strong odor makes it rather objectionable as an application.

Internal.—Being a stimulant **carminative**, it is useful in flatulent colic and other varieties of dyspepsia, and it is also of service in spasmodic affections of the stomach and bowels. In these conditions it is usually associated with other remedies. It sometimes proves successful in relieving nervous dysphagia, vomiting, hiccough, dyspnœa and dysmenorrhœa. It is said to have been used with benefit in chronic rheumatism, laryngitis, bronchitis and catarrh of the bladder, as well as in elephantiasis and certain other skin diseases. It has also been administered as a vermifuge, and prescribed, in the form of an emulsion, as an injection for thread-worms. As an internal remedy it may be taken on sugar or swallowed in capsules.

EUCALYPTUS.

1. **EUCALYPTUS.**—Eucalyptus. **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Eucalypti. — Fluidextract of Eucalyptus. **Dose, 2 c.c. (30 ♏).**

2. **OLEUM EUCALYPTI.**—Oil of Eucalyptus. **Dose, 0.5 c.c. (8 ♏).**

3. **EUCALYPTOL.**—Eucalyptol. Cineol. **Dose, 0.3 c.c. (5 ♏).**

4. **Eucalypti Gummi.**—Eucalyptus Gum (not official). (Red Gum.) **Dose, .12 to .60 gm.; 2 to 10 gr.**

ACTION OF EUCALYPTUS.

External.—Oil of eucalyptus is a very active **disinfectant.** Old oil is said to have greater antiseptic power than new, and this is thought to be due to the larger amount of ozone which it contains. As regards the antiseptic properties of eucalyptus oil, ozone is regarded as its most valuable constituent, and next to this come the pinenes and other terpenes, which are not only antiseptic in themselves, but are the agents in the production of the ozone. Recent experiments indicate that eucalyptol is the weakest antiseptic of all forms of eucalyptus, and that it is chiefly valuable as a carrier of ozone. The oil is a **rubefacient**, but less irritant to the skin than oil of turpentine and some other volatile oils. If evaporation is prevented, however, it will produce vesication, and even pustulation.

Internal. *Gastro-intestinal Tract.*—Ordinarily it produces very much the same effects as oil of turpentine in small doses, but large amounts of it are capable of exciting indigestion with eructations, and nausea, vomiting and diarrhœa, with severe abdominal pain.

Circulation.—In doses such as promote appetite and digestion it increases the heart's action and causes a rise of blood-pressure; effects which are no doubt due to the reflex stimulation from the stomach. Large doses depress the heart and cause a fall of blood-pressure, at the same time producing great muscular weakness and lowered temperature. As the arterial pressure falls in animals after section of the spinal cord or of the vagi, as well as after atropine, eucalyptus has been thought to act directly upon the heart. The **leucocytes** of the blood are **restricted** in their **movements**, diapedesis is prevented, and pus formation diminished. The surface of the red corpuscles has been observed to appear wrinkled, and the nucleus, when present, more distinct.

Respiration.—While small doses slightly accelerate the respiration, large doses depress it, and in toxic amount it causes paralysis of this function by direct action on the respiratory centre in the medulla.

Nervous System.—As in the case of turpentine, the stimulation of the central nervous system is only very transient, and is followed by marked depression. It is stated to be even a more pronounced depressant than turpentine, though consciousness is retained for a longer time. Under large or toxic doses the brain, medulla and spinal cord are all affected, the reflexes are abolished, and loss of sensation in the lower limbs may occur. Small doses have the effect of stimulating mental activity.

Spleen.—Like quinine, eucalyptus, it is believed by some, has the power of causing contraction of the spleen, though to a much smaller degree. It has also been thought to be more or less antiperiodic, but that it has any specific action of this kind is denied by competent authorities, on the ground that it has the same constituents as several other oils, and seems to have no peculiar qualities.

Absorption and Excretion.—It is absorbed from the skin, respiratory mucous membrane, and alimentary canal, and is excreted by the skin, the respiratory and other mucous membranes, and the kidneys. It imparts its odor to the breath and the urine, and is somewhat irritant at the points of elimination. It therefore has more or less action as a diaphoretic, expectorant, diuretic, and stimulant to the genito-urinary tract.

In a case of fatal poisoning by oil of eucalyptus death was preceded by great embarrassment of respiration. *Post mortem* there was found a large quantity of blood in the pleural cavities, the lungs were collapsed and bloodless, and the right heart contained frothy blood.

Red gum is a useful **astringent** and has the advantage over some others of its class that its effects upon mucous membranes are peculiarly permanent. It closely resembles kino, but does not equal it in astringency.

THERAPEUTICS OF EUCALYPTUS.

External.—It is used as an antiseptic in surgery, and is preferred by some to phenol. As a wash or dressing for wounds, sores, etc., and especially for chronic, indolent, or unhealthy ulcers, a weak solution of the oil in alcohol, may be employed. A soap containing 5 per cent. of the oil is of service in the treatment of foul wounds or ulcers and of bromidrosis. An ointment composed of eucalyptus, 8, iodoform, 1, hard paraffin, 40, vaseline, 40, is a good application for chancres and chancroids, and the oil in the form of an emulsion (1 to 50), may be advantageously used as an injection in gonorrhœa. The oil has been employed as a mild counter-irritant in affections of the chest and of the joints, and its local stimulant effects sometimes prove valuable in the treatment of anidrosis and of alopecia. It is a serviceable addition to other medicaments in ointments for chronic eczema and other cutaneous affections. A 10 per cent. solution of eucalyptol in pure alcohol has been used as a local antiseptic application in diphtheria, and the oil in a vaporized state has been employed for inhalations in this disease. Similar inhalations may likewise be given in pulmonary tuberculosis, dilated bronchi, bronchitis with fetid expectoration, gangrene of the lungs, ozæna, etc. In phthisis not much is to be hoped for in the way of permanent benefit, as the tubercle bacillus has been found to be peculiarly resistant to the action of the volatile oils. In asthma, eucalyptus-leaves are sometimes smoked in cigarettes made with stramonium-leaves and belladonna or cocoa, but how much of the benefit derived from their use is attributable to the eucalyptus seems rather uncertain. A decoction of the leaves may be used as an injection for thread-worms. In cancer of the rectum or uterus the topical application of eucalyptus frequently diminishes the amount and fetor of the discharges.

It is worth noting that eucalyptus is of service in preserving solutions of alkaloids designed for hypodermatic use. An aqueous preparation will prevent the development of the penicillium which rapidly destroys the alkaloid when the solution is made with simple distilled water.

Internal.—Eucalyptus is useful as a stomachic and carminative, provided no inflammatory action is present, in atonic dyspepsia, and in chronic gastric and intestinal catarrh. In consequence of its action the alimentary tract becomes more healthy, and no longer affords a place of development for parasites, and it is especially efficient in the form of vomiting and indigestion caused by sarcinæ. In convalescence from acute disease, in debility arising from defective assimilation, and in cachectic conditions generally, it strengthens the action of the heart and often constitutes a satisfactory tonic and stimulant. Hysteria, neurasthenia, chorea, and similar conditions, as well as cerebral anæmia, may be benefited by eucalyptus, and, like oil of cajuput, it is likely to be of service in the nervous phenomena which characterize the climacteric period. It has been known to afford decided relief in the headache which accompanies epidemic influenza, and may sometimes likewise prove efficacious in migraine and other forms of headache. The remedy is especially valuable in subacute and chronic catarrhal affections of the bronchial mucous membrane and that of the genito-urinary organs, by both of which it is excreted. There seems to be no question of its value in the declining stage of pneumonia, in pulmonary gangrene, in chronic bronchitis, and particularly in bronchorrhœa and fetid bronchitis. It has been given in tuberculosis, in the hope that in its excretion through the lungs it would exercise an antiseptic action. The objection has been raised, however, that the traces excreted in this way are quite incapable of any noticeable effect on microbial growth, while, as has been mentioned, the tubercle bacillus appears to be peculiarly resistant to this class of remedies. Among the genito-urinary affections in which it has been found of service may be mentioned chronic desquamative nephritis, granular degeneration of the kidneys, pyelonephritis, hydronephrosis, gleet, and particularly chronic catarrh of the bladder. In these conditions it is necessary, however, to administer it with caution and not to use it too long continuously, on account of the danger of exciting renal congestion and irritation. In the hope that it might prove beneficial as an antipyretic and internal antiseptic, oil of eucalyptus has been given both by the mouth and by hypodermatic injection in pyæmia, septicæmia and puerperal fever, as well as in typhoid and scarlet fevers. While the results from its use have sometimes appeared to be favorable, the remedy would seem to possess no special advantages over the other volatile oils. For subcutaneous use it is diluted with olive oil (1 to 4).

There is considerable difference of opinion as to the value of eucalyptus in malarial fever. By some it was at one time thought, like quinine, to have a specific action in this disease, but this opinion has now been abandoned by most observers. If it has any such effect at all, it is positive that it is vastly inferior to that of the cinchona preparations. At the same time, it appears to have a certain amount of usefulness as a remedy for malarial conditions, and some of the most experienced clinicians have found it very serviceable in the convalescence from intermittent and remittent fevers and in chronic malarial poisoning. While it cannot by any means take the place of quinine in arresting the paroxysms or preventing relapses at the septenary periods, it is asserted that it is even more useful than that remedy for reconstructing the damages in the organs of assimilation occasioned by the malarial infection. It has sometimes proved curative in cases where quinine had failed. Eucalyptus trees have been largely cultivated in malarial regions, with the effect of often improving markedly the healthfulness of such districts. This result has been attributed in part to the action of the eucalyptus in purifying the atmosphere in its vicinity by its aseptic emanations, but it would seem to be due rather to the drying of the soil, in consequence of the large amount of water withdrawn from it by the rapidly growing tree.

Red gum is employed in the same kinds of cases as other vegetable astringents. One of its chief uses is, in the form of lozenges, each containing .06 gm. (1 gr.), in relaxed and other conditions of the throat requiring an astringent. Internally it is given in decoction (1 to 40); the dose for diarrhœa being 8 to 15 c.c. (2 to 4 fl. dr.). The decoction is frequently employed as a gargle. A suppository containing 30 gm. (5 gr.) is sometimes of service in hæmorrhoids.

OIL OF ROSEMARY.

OLEUM ROSMARINI.—Oil of Rosemary. **Dose, 0.2 c.c. (3 ♏).**

Action of Oil of Rosemary.

The action of oil of rosemary is like that of other similar volatile oils. It is said, especially when inhaled, to reduce the body-heat and impart to the urine a violaceous odor.

Therapeutics of Oil of Rosemary.

Rosemary is employed chiefly as an external stimulant in lotions, liniments and ointments. In facial acne it is thought to have a special beneficial action. It is frequently prescribed with tincture of cantharides and Cologne water in alopecia resulting from defective nutrition of the hair-bulbs, and, on account of its parasiticidal property, it is efficacious in applications for scabies and the different varieties of pediculosis. As an ingredient of rubefacient liniments it is serviceable for sprains and painful joints, and a compound rosemary ointment (consisting of one part each of the oils of rosemary and juniper in thirty parts of ointment) may be employed in neuralgia, lumbago, chronic rheumatism, etc. Oil of rosemary is also largely used simply to give a pleasant scent to lotions and other preparations for external use.

Internally, it is occasionally given as a carminative in flatulence and colic and as a stimulant in hysteria accompanied by depressed spirits.

ARNICA.

ARNICA.—Arnica. **Dose, 1 gm. (15 gr.).**

Preparation.

Tinctura Arnicæ.—Tincture of Arnica. **Dose, 1 c.c. (15 ♏).**

Action of Arnica.

On account of its volatile oil, arnica has the same action as the volatile oils in general. In large doses it is a gastro-intestinal irritant, causing vomiting and purging, and also produces headache, unconsciousness, fall of temperature, paralysis of the nervous system (motor and sensory), and sometimes collapse and death. In some cases convulsions occur. In moderate doses it slows the pulse, raises the blood-pressure slightly, and stimulates the vagus nerves, while toxic amounts produce a rapid pulse from paralysis of these nerves. Arnica is excreted mainly by the kidneys and mucous membranes.

Therapeutics of Arnica.

External.—The diluted tincture is used for myalgia, sprains, bruises and external inflammations generally, and is a very popular domestic remedy for such affections. It should not be applied if the skin is broken, and should always be used with caution if the integument is sensitive. Some individuals appear to have a special indiosyncrasy in respect to arnica, and in such there may be caused by it violent cutaneous inflammation, with the production of pustules, or even distinct bullæ, attended with severe constitutional symptoms. The idiosyncrasy is found to be often marked in the gouty. Some authorities assert that any good effects which tincture of arnica may have, such as causing absorption of ecchymoses, are in reality due to the alcohol; on the other hand, it is claimed that the infusion (not official), which is made with water only, is even more efficacious as a local application than the tincture. Clinical experience shows that arnica often has a very effective local action, particularly in rheumatism, boils, abscesses, and in all thickened conditions of the integument, and that it also has some influence over hæmorrhages.

Internal.—Except as a stomachic, carminative and reflex stimulant, .when given in small doses, many writers consider arnica, internally, as too unreliable in its effects to be of much therapeutic value. Others, however, confidently assert that it is a remedy of distinct usefulness in a very considerable variety of conditions. Thus, it is claimed that ecchymoses are rapidly dispersed by its internal, as well as its external administration, and that for internal contusions from shock or concussion its use by the mouth has proved very efficacious. Furthermore, that it has rendered good service in typhus and typhoid fevers (as a stimulant and antipyretic), delirium tremens, rheumatism and rheumatic gout, epistaxis, hæmoptysis and other hæmorrhages, paralysis of the bladder, and chronic dysentery. The assertion is made that it has often checked an exhausting diarrhœa after many other remedies have failed, and that it has also been found beneficial in acute eczema, in erysipelas, and in other cutaneous affections of gouty or rheumatic origin. Many of these claims would seem to be exaggerated.

MEZEREUM.

MEZEREUM.—Mezereum. (Mezereon.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Fluidextractum Mezerei.—Fluidextract of Mezereum.

ACTION OF MEZEREUM.

External.—Mezereum has the same action as volatile oils generally. It is a rubefacient and vesicant externally.

Internal.—It is a gastric stimulant, producing in large doses, vomiting and diarrhœa.

THERAPEUTICS OF MEZEREUM.

External.—Almost its only external use at present is to keep open an issue, a procedure which is now very rarely employed. In the mouth, mezereum-bark has been successfully employed to relieve toothache, and also as a sialogogue.

Internal.—Internally its use is now practically restricted to its administration, in combination with sarsaparilla, as an alterative in syphilis, chronic rheumatism, and chronic skin diseases, in all of which its value is very doubtful.

(*b*) Acting generally.

AMYL NITRITE.

AMYLIS NITRIS.—Amyl Nitrite. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF AMYL NITRITE.

External.—Amyl nitrite has no irritating qualities, but it causes loss of functional power in tissues with which it is brought into contact. When externally applied, therefore, it temporarily diminishes the activity of the sensory nerves.

Internal.—When it is taken into the system by inhalation, the usual mode of administration, its characteristic effects are produced with extraordinary rapidity, and if the dose is small they are evanescent.

Circulation.—Immediately on its inhalation there follow marked **flushing** of the face, pain, heat, and a sense of fullness in the head, giddiness, throbbing of the temporal and carotid arteries, and a **rapid** and **tumultuous** action of the **heart.** Sometimes, it is stated, the cardiac disturbance is distinctly manifest before the other symptoms. While the area of redness usually corresponds with that involved in blushing, it may extend over the entire trunk, and the flushing is due to the **dilatation of the**

peripheral blood-vessels, both arteries and veins. It is supposed that these vessels in the face and neck occupy a somewhat exceptional position as regards their innervation and their susceptibility to the action of drugs, and as the meningeal vessels are also concerned in the dilatation, the various symptoms mentioned are readily accounted for. The vascular dilatation spreads from the parts originally affected over the entire body, although the vessels of the extremities are involved to a less extent than those of the abdominal region. It seems probable that depression of the vaso-constrictor centre is concerned to some extent in the general vascular dilatation, but this has never as yet been demonstrated, and is certainly not the main cause, since it has been shown positively that amyl nitrite produces dilatation by acting on peripheral structures. The seat of action of the drug is held to be the unstriated muscle of the arteries and veins, and the depression of this tissue and of the nerve terminations is now generally considered as the essential cause of the dilatation. That there is, however, an early central action, which later is overshadowed by this peripheral influence, it is thought may perhaps be indicated by the rapidity with which the flushing of the face comes on and disappears. In experiments upon animals it has been found that the vascular dilatation is followed by a marked decline in blood-pressure, and in this it is believed that the heart is not concerned. The great acceleration of the heart has been mentioned, and in consequence of this there may at first perhaps be even a rise of blood-pressure, the dilatation being more than overcome by the quickened beat; but as the dilatation extends throughout the body, the relaxation, particularly in the splanchnic area, soon has the effect of producing a profound fall in the blood-pressure. It also causes a dicrotic pulse. The tachycardia is generally attributed to a depression of the inhibitory (vagus) centre in the medulla, though vaso-motor paralysis would also produce a rapid pulse, and by some it is thought that there is present, in addition, a feeble direct action on the heart. Large doses of amyl nitrite slow and weaken the cardiac contractions and finally arrest them, owing to direct muscular depression; but this direct action on the heart muscle, it is found, is produced much less readily than that on arterial muscle. While the drug has such a marked influence in accelerating the beat, no perceptible alteration in the force of the latter is caused by it.

Respiration.—The quickness of the action of amyl nitrite is due to the extraordinary rapidity with which it is absorbed, especially through the lungs, and its first effects resemble very closely an incipient asphyxia. Sometimes, as in the case of ether, chloroform and other similar agents, the breath is held in the beginning, in consequence of a reflex from the nasal mucous membrane. Under the stimulating effect of the drug upon the respiratory centre in the medulla the respiration is quickened and deepened, but if the inhalation is maintained sufficiently long, this effect is replaced by a depressing one, and, in consequence, the respiratory movements are rendered more slow and shallow; death eventually occurring from **asphyxia** due to a complete paralysis of the centre.

Blood.—The immediate cause of the asphyxia is the production of **methæmoglobin**, a compound which parts with its oxygen much less readily than oxyhæmoglobin, but which is eventually broken up by the tissues. The nitrites, however, unlike most other agents which change hæmoglobin into methæmoglobin, do not have the power of causing destruction of the red corpuscles; so that the only action is interference with oxidation. This effect is seen in the change of the color of the blood to a dark chocolate in animals. In man very little of the methæmoglobin formation process usually occurs, even after the inhalation of very large amounts.

Kidneys.—The only effect of the drug on the urinary secretion appears to be one dependent upon its action on the circulatory system. If, therefore, the renal arterioles are relatively more dilated than those of the general circulation, the flow of urine will be increased, while if the reverse of this condition is present, it will be diminished. Its diuretic influence is never very marked, and if large amounts are taken, so that the blood-pressure is reduced to a low point, complete anuria may result. Sometimes in animals there is persistent glycosuria, and it is thought that this may perhaps be due to the partial asphyxiation of the tissues resulting from the formation of methæmoglobin. Amyl nitrite when given either by the mouth or by subcutaneous injection acts much less quickly and powerfully than when absorbed by the lungs, and it is stated that when administered hypodermatically it generally gives rise to glycosuria and slight diuresis.

Nervous System.—Amyl nitrite is not known to exert any influence on the higher cerebral centres. The spinal cord is not acted upon in mammals, but is depressed in the frog. Its effects on the vagus and respiratory centres in the medulla have been mentioned. While, as stated, action upon the vaso-motor centre has not been demonstrated, it seems probable that the drug does possess such action; which, however, must be quite insignificant when compared with its effects on the peripheral vaso-constrictor mechanism. It acts not only upon the muscular coats of the vessels, but also produces slow paralysis of muscle of all kinds with which it comes in contact. The pain and sense of fullness in the head, as well as the giddiness and other symptoms following immediately upon inhalation, result from the vascular dilatation, in which the cerebral circulation fully participates, and the headache may persist for a considerable time. If large quantities are inhaled, there may be unsteadiness of gait and some confusion and restlessness. The pupils are dilated and disturbances of vision are apt to occur. Some individuals in looking at a dark object on a white background see it surrounded by a yellow circle, outside of which there is a blue circle. Convulsions are not infrequently observed in animals. They are probably of cerebral origin, and, if so, due to direct action upon the nerve cells, and not dependent on the circulatory changes.

THERAPEUTICS OF AMYL NITRITE.

Heart and Blood-vessels.—In attacks of angina pectoris amyl nitrite is of great service, provided the arterial tension is high. When the rise of blood-pressure is due to a nervous contracture of the vessels, it is certain to give relief. In many instances where valvular disease of the heart is present, as well as in those in which there is merely functional disorder, it acts most promptly and efficiently. The nitrites are regarded as the most powerful pressure depressants known, and the action of amyl nitrite in the dyspnœa of cases of cardiac disease may, it is thought, be due to its lowering the pressure in the systemic arteries and thus relieving the heart. Its beneficial effects would not therefore result from any direct action on the heart, but from its decreasing the resistance against which the systole is performed. Its physiological action in accelerating the pulse-rate has led to its recommendation in all forms of sudden heart-failure, even when such failure is dependent upon fatty degeneration or other disease of the heart itself. It may be stated, however, that in very advanced degeneration of the cardiac muscle fibre it is distinctly contra-indicated, since, the blood-pressure already being low, any further reduction may induce syncope from cerebral anæmia, while the heart may be still further weakened by the lessening of its nutrition from lowered pressure in the coronary arteries. The use of the drug would also seem to be unsafe when advanced degeneration of the cerebral vessels exists. It may be employed in all cases in which, there being no contra-indication to its use present, it is desired to reduce the arterial tension. In practice it is found that dyspnœic attacks connected with heart failure from valvular disease and other causes are not infrequently relieved by it. In spite of the fact that amyl nitrite, if used freely, is capable of producing syncope by its depressing influence on the heart, it is claimed that in many cases of syncope and collapse, depending on a variety of conditions, recovery has attended its administration by inhalation.

It has even been recommended and used in chloroform syncope, and a considerable number of instances have been recorded in which the patients, it is asserted, were rescued by it from impending death. On the other hand, it is the opinion of some of the highest authorities on the action of drugs that these patients recovered in spite of and not in consequence of its use. It would appear to be strongly contra-indicated, they state, in those cases in which it is true that the heart is depressed, but in which the arterial tension is practically zero; and its use is especially irrational if, as has been suggested, the failure of the respiration is partly due to anæmia of the central nervous system. The reasoning of those who advocate the exhibition of amyl nitrite is as follows: It is certain that chloroform contracts, and that amyl nitrite dilates, the capillaries of the brain and of the skin of the face; under the former the patient grows pale, under the latter he is flushed. In experiments upon animals if the nitrite be used in excessive dose, cyanosis arises in consequence of venous engorgement. Experiments have also shown that if it is given in full doses to an animal already narcotized by chloroform, it deepens instead of relieving the narcotism, while if it be administered in moderate quantities, either by inhalation or hypodermatically, it revives the heart's action and removes the pallor caused by the chloroform. The salutary or pernicious effects of the nitrite therefore being due to the amount of it administered, they regard its beneficial action as happily illustrated in the cases referred to. In threatened death from chloroform the plan has been adopted by some of placing over the patient's face a little lint on which amyl nitrite is sprinkled, and at the same time carrying on artificial respiration. A small amount of the vapor may no doubt be of service in certain cases of syncope and cardiac failure where deep inhalations might perhaps be a source of danger. In heart-failure from fright, for instance, it has often proved of great value in single whiffs, but if it does not afford relief at once it is worse than useless to continue it.

Aside from cardiac affections, it is especially indicated in various morbid conditions resulting from vaso-motor spasm, and may be employed in all cases in which dilatation of the capillaries is likely to prove of service. For relaxing general spasm and spasm of either vaso-motor muscular fibres or the voluntary or involuntary muscles it is a highly esteemed remedy. In tetanus and in strychnine poisoning it is worth trying and may prove of distinct value. It should be used between the spasms or else administered by subcutaneous injection, as the respiratory cramp interferes with its absorption by inhalation. Good results have been reported from its employment in *trismus nascentium*. In persistent hiccough the inhalation of amyl nitrite has been known to arrest the spasm of the diaphragm after various other measures had failed.

Considerable attention has been paid to its use in the treatment of epilepsy. There can be no question of its utility in many cases in which the paroxysm is preceded by an aura giving the patient warning of its onset. By relieving the vaso-motor spasm of the cerebral vessels it often serves to prevent the occurrence of the fit if inhaled in time, and consequently epileptics who have such a warning of impending seizures should always be provided with a supply of the nitrite, which can be most conveniently used when put up in little glass capsules known as "pearls," each containing .30 gm. (5 ♏), which can be readily crushed in the handkerchief. After the paroxysm has commenced the remedy is hardly likely to be of much service, except in those cases which are apparently dependent on a vaso-motor spasm of the vessels supplying the motor areas, and if resorted to should be employed with caution, because its early effects will be obscured by the patient's condition. In what is known as the *status epilepticus,* however, where there is a series of recurring paroxysms, it has sometimes been found of great service in putting a stop to the convulsions. One of the uses of amyl nitrite is as a means of diagnosis between true *petit mal* and cases in which that affection is simulated by attacks caused by temporary congestion of the nerve-centres. In the latter the nitrite, instead of alleviating the condition, intensifies the paroxysm. It should be mentioned that certain authorities regard this agent of little or no value in spasmodic seizures, such as epilepsy, and state that in some cases it even seems to increase the tendency to convulsions. Good results have been claimed by some from its use in the treatment of puerperal eclampsia, but it should never be employed when the convulsions continue after parturition or come on subsequently to the birth of the child, on account of the great danger of its inducing hæmorrhage by relaxing the uterus. It is also stated to be useful for relieving after-pains, but its administration for this purpose is contra-indicated for the same reason. In any convulsive disorder in which the condition is regarded as attributable to a vaso-motor spasm of the vessels supplying the motor areas it would naturally be likely to prove beneficial. In many cases of hysterical convulsions, whatever may be the primary cause of the nervous trouble, such a state of vaso-motor spasm undoubtedly exists, if only a link in the pathological chain, and in practice it has not infrequently been found to arrest the paroxysms, while not controlling other symptoms. In infantile convulsions it has also sometimes proved of service. Amyl nitrite is antagonistic to ergot in its action. It may therefore be given to counteract the evil effects of this drug, and its inhalation has been known to promptly reduce hour-glass contraction of the uterus caused by the latter.

It may often be used with advantage in various painful affections in which there is a spasmodic element, and among these may be mentioned spasmodic dysmenorrhœa, angiospastic hemicrania, and chordee. In those cases of migraine in which there is local vaso-motor spasm, causing contraction of the capillaries, it is a most valuable remedy; but if, instead of a pallid there is a flushed countenance, with conjunctival injection, it will only aggravate the patient's suffering. As to headache in general, it will sometimes relieve and sometimes increase the pain, its beneficial effect or the reverse depending largely on whether the arterioles are constricted or dilated. Neuralgia of the fifth nerve and other neuralgias are at times relieved and in some instances cured by it. If the pain is mitigated or removed by it, but subsequently returns, the inhalations should be repeated from time to time as required. In that distressing affection *tinnitus aurium,* which is also often very obstinate, decided benefit in a considerable proportion of cases has been derived from its use.

In its action of relieving spasm of the muscular system generally, as well as of the arterioles, are included the bronchial tubes, and hence it has been found a valuable remedy for the symptom asthma. In the paroxysms of typical asthma it usually, though not always, affords immediate and complete relief. What interferes to a considerable extent with its usefulness, however, is the fact that the patient rapidly becomes accustomed to its employment, and hence increasing doses are necessary when it has to be administered frequently in the same case, in order to overcome the diminution in the effects resulting from repetition. This naturally applies to other affections also. Amyl nitrite may often be used with advantage in the treatment of catarrhal spasm or pseudo-croup of children and of the various forms of laryngismus; and in some instances is of service in Cheyne-Stokes respiration. It is said to have sometimes proved efficacious in the vomiting of pregnancy, and there can be little question of its beneficial effect in many, though by no means all, cases of seasickness. In intermittent fever it will abort the cold stage of the paroxysm, but has no influence upon the ensuing hot stage. It would seem that the drug might be decidedly valuable in the dangerous algid stage of pernicious malarial fever.

TOXICOLOGY.

So far as known, only one death has occurred from the use of amyl nitrite (in this case a patient suffering from pulmonary tuberculosis took a large quantity by inhalation); but in a considerable number of instances very alarming symptoms have been caused by it, and several cases are on record in which very small, and even minute, doses produced unconsciousness.

Treatment.—In case of serious symptoms arising from its use vomiting may be caused, if necessary, by apomorphine or other emetics. Its effects should then be counteracted by the employment of artificial respiration and by the subcutaneous injection of strychnine and digitalis, the latter of which has an antagonistic action on the circulatory system. Other measures recommended are the exhibition of ammonia by inhalation, by the mouth, or by intra-venous injection, and the hypodermatic use of atropine or ether. At the same time cold water or an ice bag may be applied to the head, and a sinapism to the epigastrium. A hot mustard foot-bath may also be given, the patient being kept in a recumbent position.

NITROGLYCERIN.

SPIRITUS GLYCERYLIS NITRATIS.—Spirit of Glyceryl Trinitrate. Spirit of Nitroglycerin. (Spirit of Glonoin.) **Dose, 0.05 c.c. (1 ♏).**

ACTION OF NITROGLYCERIN.

It is at first sweetish to the taste, but afterwards gives an impression of aromatic pungency. Its action is practically the same as that of **amyl nitrite,** but its effects on the system are produced with less rapidity and last considerably longer. The **headache** caused by it is frontal, and of great **severity**, and often persists for hours after the other effects have disappeared. Nitroglycerin is a nitrate, and the similarity of its action to that of amyl nitrite and other nitrites is due to the fact that it is readily converted into nitrites in the presence of alkalies, a change which has been demonstrated to take place in the blood. It is thought probable that the action of all the nitrite group is due to the effects of nitrous acid. There appears to be a very great difference in the susceptibility of different individuals to the influence of nitroglycerin. While in one person 0.0013 gm. ($\frac{1}{50}$ grain) may give rise to its full physiological effects, it may take twenty-five times that amount to produce the same result in another. Very small doses have been known to cause unconsciousness and complete disappearance of the pulse at the wrist. After toxic quantities there is a marked failure of cardiac action. A number of deaths have been reported from over-doses of the drug, and in these cases there were vomiting and purging, while the immediate cause of the fatal result seemed to be failure of the respiration. It may be mentioned that, after gradually increasing the quantity, as much as 0.39 gm. (6 grains) of nitroglycerin for a dose has been given regularly, not only without any serious consequences, but with apparent advantage.

THERAPEUTICS OF NITROGLYCERIN.

Its most important use is for the relief of symptoms associated with the high tension pulse of chronic renal degeneration. Here the dose should be rapidly increased until relief is obtained. In general, it is much relied upon in cases of habitual high pressure, especially of arterial sclerosis in which the increased peripheral resistance is developing, or has produced, increased cardiac power. It is also of service in many of the affections in which amyl nitrite is used, and has the advantage of being more lasting in its effects. Among these may be mentioned asthma, angina pectoris, cardiac failure, seasickness, reflex vomiting, gastralgia, hepatic colic, hiccough, laryngismus, neuralgia of the fifth nerve, migraine (when the face is pallid), neuralgic dysmenorrhœa, epilepsy, and tetanus. In some cases of chorea it is also said to have been efficient. In angina pectoris (in which amyl nitrite is generally to be preferred if the utmost promptitude is required), it will naturally prove of the most benefit in cases characterized by high tension of the peripheral vessels. A very happy application of nitroglycerin is in the warding off of anticipated attacks of angina. A patient subject to such may take a sufficient dose of the remedy a few minutes before making any exertion which experience has shown is likely to bring on a paroxysm, or he may be able to prevent the attacks by using minute doses at frequent intervals during the entire day. In heart troubles, whether valvular disease is present or not, it often affords the most efficient relief, and in all the various forms of cardiac dyspnœa it is of the greatest possible service. It appears to do good by restoring or approximately restoring, at least for a time, the normal relationship between the force of the heart's action and the resistance of the vessels, and the pulmonary circulation itself is no doubt favorably affected by its action. Its beneficial effects are not so much due to any direct action on the heart as to its diminishing the resistance against which the systole is performed; so that the contraction of the ventricle is rendered more complete, and the output of the heart increased. It has been noted that the continuous want of breath met with in some cases of cardiac failure is less amenable to such relief than dyspnœa which is more paroxysmal in character. Nitroglycerin may often be combined very advantageously with digitalis in organic disease of the heart, in order to neutralize the marked vaso-constriction caused by that drug. Digitalis has unquestionably been used far too indiscriminately in cardiac affections; but it has been remarked by those who have had good opportunities for observation that during the past few years, in which the nitrites have been commonly used in this way, digitalis has been productive of much less harmful results than formerly. Nitroglycerin is, then, an efficient and generally safe remedy, and it can be given, in sufficient quantity to secure the desired action, for long periods without ill effects. It has been recommended in the algid stage of cholera and, injected subcutaneously, has been found of service in poisoning by illuminating gas. The severe headache which it is apt to produce is found in a considerable proportion of cases to disappear after repeated employment.

SODIUM NITRITE.

SODII NITRIS.—Sodium Nitrite. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

ACTION OF SODIUM NITRITE.

External.—Locally applied, sodium nitrite, like amyl nitrite tends to destroy the functional activity of the tissues.

Internal.—Under the effect of a moderate dose of sodium nitrite the heart's action is slightly quickened and the pulse tension falls. There may or may not be some feeling of fullness in the head, but not often any throbbing, and there is generally no flushing of the face. With larger doses the fall of tension is very marked and the same characteristic symptoms in general are produced as in the case of amyl nitrite. Sometimes profuse perspiration and more or less cyanosis are seen, and faintness and nausea may occur. In those specially susceptible to the influence of the drug partial unconsciousness and collapse may result. It appears to have a depressing action upon muscular tissue, and in the frog, contrary to the effect of amyl nitrite, the muscles are paralyzed before the spinal cord. It is both absorbed and eliminated more slowly than either amyl nitrite or nitroglycerin, and its effects on the system are very much more permanent than those of the former and considerably more lasting than those of the latter. One disadvantage connected with its administration is the eructations to which it frequently gives rise, in consequence of the fact that part of its nitrous acid is liberated by the action of the gastric juice before absorption can take place. Some irritation of the gastro-intestinal mucous membrane also is liable to be caused by the nitric acid formed from it. The greater part of the nitrite which is absorbed is excreted as nitrate in the urine, but some of it may remain unoxidized. In experiments on small animals, such as cats and guinea-pigs, it has been found that lethal amounts of sodium nitrite produce general sedation, muscular paresis, slowing of the heart, fall of arterial tension, cyanosis, asphyxia and paralysis, while after death the heart and lungs are seen to be gorged with black or chocolate-colored blood.

THERAPEUTICS OF SODIUM NITRITE.

The action of this agent, though apparently milder and less certain in effect, is analogous to that of amyl nitrite and nitroglycerin, and it may be employed in the various conditions in which these drugs are of service. As a matter of fact, however, it is much more rarely used in medical practice than either of them. Wherever an immediate and powerful effect is desired they are both to be preferred to it, and while its effects may be more lasting, nitroglycerin is so extremely easy of administration that its repetition at sufficiently frequent intervals will prolong its influence to any required extent. In some cases, however, it may be found to act more satisfactorily than nitroglycerin, and as it is much less likely to produce severe headache than the latter, it may be advantageously substituted for it in patients in whom the headache proves an objection. As sodium nitrite is liable to be decomposed by the gastric acids, it has been recommended that it should be given in an alkaline solution.

SPIRIT OF NITROUS ETHER.

SPIRITUS ÆTHERIS NITROSI.—Spirit of Nitrous Ether. (Sweet Spirit of Nitre.) **Dose, 2 c.c. (30 ♏).**

ACTION OF SPIRIT OF NITROUS ETHER.

External.—When applied to the cutaneous surface it quickly evaporates, giving rise to a slightly **anæsthetic** effect.

Internal.—Spirit of nitrous ether, although it has long been extremely popular as a diaphoretic and a diuretic, has been found to have in reality little action upon either the skin or the kidneys, while it is inefficient in the reduction of temperature. Its principal value is as a **carminative** and **diffusible stimulant.** It also has some antispasmodic influence, and acts as a mild sedative to the nervous and circulatory systems. Its physiological action as a nitrite is but feeble as compared with that of amyl nitrite, sodium nitrite, or nitroglycerin, its effects in this respect being overcome or modified by the alcohol entering into its composition. In the case of a child of three years who died from taking 120 c.c. (4 ounces) of the spirit, the symptoms were those of alcoholic poisoning, with the addition of vomiting and purging. It should not be kept too long, as it is liable to turn acid after a time.

THERAPEUTICS OF SPIRIT OF NITROUS ETHER.

This time-honored remedy, so long and universally given as a diuretic, diaphoretic and antipyretic, no longer enjoys the vogue that it formerly held. It has, however, a limited sphere of usefulness. It may be given with good effect to children, particularly, suffering from feverishness with nervous symptoms or mental excitement. Here it often has a pleasantly calmative influence, quieting the restlessness and promoting sleep. On account of its stimulating qualities it is especially serviceable in adynamic conditions. It is a grateful stomachic and carminative, and is useful, especially when associated with aromatic spirit of ammonia, in allaying nausea and causing the expulsion of flatus. In asthma and bronchitis it may be of assistance in relieving spasm and increasing the secretions of the mucous membrane, and it is frequently employed as a constituent of expectorant mixtures. It is also used to some extent in combination with diuretics. Externally, it sometimes proves a soothing application to the forehead in neuralgic headache.

ERYTHROL NITRATE.

Erythrol Nitras.—Erythrol Nitrate (not official). (Erythrol Tetranitrate. Tetranitrole.) **Dose, .03 to .06 gm.; ½ to 1 gr.**

ACTION OF ERYTHROL NITRATE.

Like nitroglycerin, this is a dangerous explosive, and at least one fatal accident has occurred from its trituration in a mortar with glucose. It has the same general action as the nitrites, causing dilatation of the vessels and a marked fall in blood-pressure, together with the formation of methæmoglobin. In the case of this drug and mannitol hexanitrate (not official) the characteristic effects on the system are produced more slowly and gradually, and last for a longer time, than under the influence of any others of the group. Its alcoholic solution is explosive, and it is therefore recommended that it should always be used in tablet form.

THERAPEUTICS OF ERYTHROL NITRATE.

It is highly recommended in the treatment of angina pectoris, although, like other members of the nitrite series, it sometimes fails to give relief. It is often of special value, however, in warding off attacks of angina, for, while its influence is not exerted for half an hour or longer after ingestion, it is capable of preventing the attacks for four or five hours. Some authorities, indeed, advise that the remedy should be used for this purpose solely; but this is a great mistake, as it has proved of very marked service in other conditions also. It is considered by many to be the best of the series for the relief of some of the symptoms of Bright's disease, and in cardiac affections, whether associated with renal trouble or not, it can often be relied upon with great confidence. This drug, it can scarcely be doubted, has not as yet been as generally employed as its merits deserve, and there can be little question that for constant use erythrol nitrate, properly administered, is superior to the more evanescent nitroglycerin and the somewhat uncertain sodium nitrite. It has been recently recommended in lead-poisoning with high arterial tension.

2. Vaso-constrictors.

(*a*) Acting locally.

TANNIC ACID.

QUERCUS.—White Oak. **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Quercus.—Fluidextract of Quercus. **Dose, 1 c.c. (15 ♏).**

GALLA.—Nutgall. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Tinctura Gallæ.**—Tincture of Nutgall. **Dose, 4 c.c. (1 fl. dr.).**

2. **Unguentum Gallæ.**—Nutgall Ointment.

ACIDUM TANNICUM.—Tannic Acid. (Tannin.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Collodium Stypticum.**—Styptic Collodion.
2. **Glyceritum Acidi Tannici.**—Glycerite of Tannic Acid. **Dose, 2 c.c. (30 ♏).**
3. **Trochisci Acidi Tannici.**—Troches of Tannic Acid.
4. **Unguentum Acidi Tannici.**—Ointment of Tannic Acid.

Unofficial Preparations.

Tannalbinum.—Tannalbin. **Dose, .30 gm.; 5 gr.**
Tannigenum.—Tannigen. **Dose, .30 to 2 gm.; 5 to 30 gr.**

ACTION OF TANNIC ACID.

External.—Locally, tannic acid is an **astringent** and **hæmostatic**, and its characteristic effect is the precipitation of albumins and other proteids, as well as gelatin and many alkaloids and glucosides. The precipitate thus formed is dense and resists putrefaction. This action occurs when the acid is applied to animal tissue, as in the tanning of leather, and the result is that the hide becomes harder, tougher, and somewhat shrunken, but retains its flexibility. Tannic acid is very slightly irritant, but this effect is more than counterbalanced by its astringent action. It apparently has no action on the unbroken skin, but on mucous membrane it has the effect of causing more or less coagulation in the cells, by direct action on the cells themselves; precipitating the albumin of the secretions (which it diminishes), and forming a layer of albumin tannate which is protective and antiseptic. Applied to a bleeding surface, it thus has a hæmostatic action, coagulating the effused blood and plugging the vessels with clots, and still further tending to check hæmorrhage by the constriction of the vessels caused by the contraction of the coagulum formed within the tissues.

Internal.—Its taste is bitter, and in the mouth it produces a feeling of dryness, stiffness, and puckering. Very soon the sense of taste is partially lost, and the movements of the tongue are somewhat interfered with in consequence of the coagulation of the superficial layers of proteids both within and without the epithelium. This causes a roughness of the surface of the mucous membrane, so that the tongue cannot glide over it easily, as in the normal condition. In the throat the same feeling of astringency is experienceed. Nausea and vomiting may sometimes be caused by the drug, but this is not very often the case. In the intestines it diminishes the mucous and other glandular secretions, so that constipation results, and the fæces become dry, hard and scanty. The increased consistency of the stools is thought to be due to the layer of coagulated proteid acting as a protective to the bowel, lessening its irritability, and thus retarding its movements; so that there is longer time for the absorption of the fluid part of its contents. In the stomach tannic acid is found to combine with and precipitate any proteid substance with which it comes in contact, but, as digestion proceeds, such combination is broken up, the peptones not combining with this agent in acid solution; and the astringent action is therefore exercised on the walls of the stomach and intestines. When given in large amount, however, it sometimes causes gastro-intestinal irritation and diarrhœa. Only about one per cent. of the tannic acid swallowed reappears in the excretions, either as tannic or gallic acid; the rest would seem to undergo complete oxidation in the tissues. A small proportion is occasionally eliminated by the bowel unchanged, but the greater part is converted into gallic acid, some of which often passes out both in the stools and the urine. No evidence of any weight has been educed that tannic acid exerts any influence after it has been absorbed. It does not exist in the tissues as such, but only in the form of traces of sodium gallate or tannate, too small to have any astringent effect; and it would appear, therefore, that its action is in fact limited to the point of application. As to its effects on blood-vessels, the most recent experiments show that solutions of less strength than ½ per cent. cause constriction of the mesenteric vessels of the frog or rabbit when applied directly, while more concentrated solutions occasion transient constriction, followed by dilatation. When it is injected intravenously, the precipitate produced is found to lead to the formation of emboli.

Tannic acid is the chief principle of all the vegetable astringents. The tannic acid present is not always the same chemical body, but the various acids, such as kinotannic, etc., all have in common the power of precipitating albumins and other properties characteristic of pure tannin. The differences in the intensity of their effects is explained by the facts that some are more energetic precipitators of albumin than others, and that many of the drugs contain gum, resin and other matters which affect the solubility of the tannins.

THERAPEUTICS OF TANNIC ACID.

External.—Tannic acid is a very useful remedy, and its applications are quite extensive both in surgery and medicine. It is employed to control bleeding in various parts of the body, and it may, if practicable, be dusted on the part, or be applied in the form of the glycerite or of styptic collodion. The latter is of special service in uniting incised wounds and protecting lacerated wounds. When applied on wounded or abraded surfaces it checks the oozing and forms a firm coating in which the coagulated blood and secretions participate, and which excludes the air from the part. In order to produce special effects on the diseased surface various agents, such as phenol, iodine, or morphine, may be incorporated in the preparation, as desired, and carbolized styptic colloid, in which advantage is taken of the antiseptic and styptic properties of phenol, is a very efficient hæmostatic. It is prepared by adding ten per cent. of phenol to the official styptic collodion.

Aside from its astringent and hæmostatic effects, tannin is of value locally for removing fetor and for preventing or checking putrefactive changes in the tissues. Among the conditions in which its application in various forms is useful may be mentioned aphthous ulceration of the mouth, spongy gums, mercurial salivation, relaxation of the uvula, pharyngitis, nasal catarrh, otorrhœa, laryngitis, chronic inflammations of the conjunctiva, leucorrhœa, urethritis, cystitis, hæmorrhoids, burns, chilblains, ulcers and other sores, and moist cutaneous eruptions. For local use the glycerite is probably the most generally satisfactory preparation of tannic acid, and the official strength may be readily altered to suit special conditions. A very concentrated solution, two parts of glycerin to one of tannin, may be made by the aid of moderate heat. This will be found very useful to prevent sore nipples if applied daily during the later months of pregnancy. The glycerite, in the strength of one part to eight of water, makes an excellent gargle. For pharyngitis and tonsillitis the troches are convenient, and a spray (1 to 2 in 100 of water) or an insufflation of tannic acid and starch may be used for the larynx, as well as the fauces. A powder made with one part of tannin to 30 of marshmallow root has been employed as a snuff to arrest acute coryza in its forming stage, and an ointment containing .06 gm. (1 gr.) of tannin and 8 gm. (2 dr.) of ointment has been applied to the nostrils, on a roll of soft linen or paper, for the same purpose in infants. In chronic nasal catarrh powdered tannin is sometimes used by insufflation. In ozæna and other affections attended with fetor tannin-wool (made by soaking wool in water, at 60° C.; 140° F., saturated with tannic acid, and drying the wool) has been found of service. The ointment of nutgall and opium (1 to 14 of nutgall ointment) is a favorite application for piles. In affections of the rectum tannic acid is recommended in the form of a suppository containing .20 gm. (3 gr.), and in those of the uterus in the form of a pencil about an inch in length, made with four parts of the acid to 1 of tragacanth. The glycerite is regarded as an excellent application for catarrhal inflammation of the cervix uteri, and even in cancer of the uterus is efficient in moderating the discharge and allaying odor. The benefit from it may be increased by combining with it the glycerite of phenol. Solutions (1 to 50) in water may be injected into the bladder for cystitis and into the urethra in the treatment of subacute gonorrhœa and gleet. Gonorrhœa has also been treated by filling the urethra (through a tube) once or twice daily with a powder consisting of equal parts of tannic acid, iodoform and thalline sulphate (not official). In women a watery solution may be used as a vaginal injection, or the vagina may be packed with gauze covered with tannin. The decoction of oak bark, employed as a high rectal injection, destroys the thread-worm. A preparation of nutgall dissolved in glycerin was formerly used as an injection into hernial sacs (Heaton's method). The temporary results were excellent, but sooner or later failures occurred in a large percentage of cases. A solution of tannic acid in tincture of benzoin (1 to 4) is said to tend to repress the development of the pustules of small-pox. A tannic acid lotion or ointment is sometimes of service in such skin affections as herpes, intertrigo, and weeping eczema, checking the discharge and allaying itching and irritation. Introduced into a carious cavity, it not infrequently relieves toothache. A concentrated solution is an excellent palliative remedy in ingrown toe-nail, especially when there are fungous growths, and is useful also for hardening tender feet. Ulcers of the rectum and anus and fissures of the anus are sometimes effectively treated by the application of the powder of tannin or iodo-tannin (solution of iodine with tannic acid).

In acute dysentery good results have been obtained by the use of hot enemata consisting of a 4 per cent. solution of boric acid in which 0.60 gm. (10 gr.) of tannin is dissolved, with the addition of a few drops of laudanum. In the early stage of cholera, also, tannic acid enemata, carried beyond the ileo-cæcal valve, have proved of service; the injections being composed of 6 to 20 gm. (1½ to 5 dr.) of tannic acid dissolved in 2 litres (4 pints) of water, with the addition of 2 c.c. (30 ♏) of laudanum and 45 gm. (1½ oz.) of powdered acacia.

Internal.—As an internal remedy pure tannic acid is of little value. It is often prescribed in internal hæmorrhages such as hæmoptysis, metrorrhagia and hæmaturia, but it is doubtful whether, except in those of the gastro-intestinal tract, where, if given in sufficient quantity, there may be some opportunity for it to exert its local action, it really does any good in these conditions. Even for hæmorrhage from the stomach or intestine other remedies are to be preferred. If employed in hæmoptysis, an atomized solution will afford the best chance of success. In excessive sweating, bronchorrhœa and leucorrhœa its internal administration has no effect in diminishing the discharge. In certain forms of diarrhœa its astringent action is of considerable value, and it may prove useful in checking the looseness of the bowels sometimes caused by such remedies as codliver oil. In these cases, however, the pure drug is seldom used, as it is liable to derange the stomach and to form compounds with the albumins before it reaches the intestine, and such agents as kino, gambir, and krameria, which owe their astringent qualities to tannic acid, are generally selected in the treatment. Remedies of this kind, whose activity depends on their containing tannic acid, differ from the pure drug in that the acid is only slowly dissolved out from the colloid mass, and therefore acts less on the stomach and affects a greater length of intestine. In chronic albuminuria the acid, in various forms, has been recommended for the purpose of checking the drain of albumin from the blood; but opinion is very divided as regards its efficacy, and it would seem altogether probable that it has no effect either in lessening the albumin in the urine or preventing its increase. As a temporary expedient in cases of poisoning with metallic compounds, such as tartar emetic, and with alkaloids, the exhibition of tannic acid may serve a useful purpose; but it should always be followed by the prompt emptying of the stomach, as otherwise the tannate formed becomes gradually dissolved in the fluids of the alimentary canal. Certain individuals, it has been found, are peculiarly susceptible to the action of tannic acid, which in such cases produces local irritation, and even inflammation, wherever it is applied. This remedy should never be used hypodermatically.

Tannalbin (not official) is a tannin albuminate which has been subjected to a dry heat of 230°–248° F. (110°–120° C.) for several hours. It is a faintly yellow, tasteless powder containing about 50 per cent. of tannic acid. Laboratory experiments have shown that it is not easily decomposed by an artificial gastric juice, but it is rapidly separated into its constituents in an alkaline medium or by an artificial solution of the pancreatic ferments. This preparation accordingly passes through the stomach unchanged, and may not be broken up until it has got well down into the intestine. Tannalbin is preferably given in wafers at frequent intervals. It has been used with considerable success in chronic diarrhœas, even in cases in which intestinal ulceration was present. It has also been highly commended in gastric catarrh, and is said to have been found useful in diminishing the amount of albumin in chronic albuminuria.

Tannigen (not official), the acetic acid ester of tannic acid, is prepared by the action of glacial acetic acid on tannic acid. It is a tasteless, odorless powder, insoluble in water, and is believed to pass unchanged through the stomach and to be slowly decomposed in the intestines, thus exerting an astringent effect in them. This preparation also is usually prescribed in wafers. It has been used to a considerable extent in the diarrhœas of children, in whom its tastelessness renders its administration very advantageous, and it has proved especially serviceable in entero-colitis. In chronic intestinal troubles it is said to have been found less successful than in acute. Some observers, however, recommend it in chronic cases, and especially in the diarrhœa of phthisis. It does not disturb the digestion, and has proved efficient in the treatment of gastric catarrh with excessive secretion of mucus. Locally applied, it appears to act well in catarrhal affections of the mucous membrane, and the powder may be used by insufflation in chronic rhinitis and laryngitis.

GALLIC ACID.

1. **ACIDUM GALLICUM.**—Gallic Acid. **Dose, 1 gm. (15 gr.).**
2. **PYROGALLOL.**—Pyrogallol.

ACTION OF GALLIC ACID.

Gallic acid, given by the mouth, is absorbed, and, as has been stated, is excreted to some extent by the kidneys; but much of it disappears in the tissues, apparently by oxidation. It does not, like tannic acid, precipitate proteids, and has therefore **no** local **styptic** or **astringent** effect. It can be taken in very large quantity without producing any symptoms, its action being simply that of a weak organic acid.

THERAPEUTICS OF GALLIC ACID.

It has been employed to a very considerable extent to produce the supposed remote astringent effects of tannic acid, which, as has been seen, becomes largely converted into it in the body. Thus, it has been commonly given in the treatment of hæmorrhage of all kinds and to some extent also in albuminuria. With our present knowledge, however, it seems probable that it has little, if any, therapeutic value. At the same time, it should be stated that it is still maintained by some clinicians of repute that it should be prescribed when astringent effects on the tissues elsewhere than the intestinal canal are desired, and that in the treatment of renal hæmorrhage it is more uniformly successful than any other remedy. It is also claimed that it is very serviceable in pyelitis, pyelo-nephritis, and catarrh of the bladder, as well as in chronic bronchial catarrh when the latter is the sequel of acute bronchitis or the result of the irritation extending from disease of the parenchyma of the lung, or when it is produced by mitral or tricuspid regurgitation. Others hold that, combined with opium, it is one of the best remedies in diabetes insipidus, and is even useful in diabetes mellitus; but it is probably the fact that whatever benefit may be found in these cases is due entirely to the effect of the opium. It is also stated to have proved efficient in pyrosis, which is an annoying symptom of various dyspeptic conditions.

ACTION OF PYROGALLOL.

In its effects on the system, as well as chemically, pyrogallol is more nearly related to phenol than to gallic acid. When administered in large quantities to animals it gives rise to nervous symptoms analogous to those caused by carbolic acid, but in man, even in poisonous doses, it does not produce these nervous symptoms, or at all events to a very small extent; while the other phenomena are similar to those observed in animals when smaller quantities are exhibited. The poison acts not so much directly on the central nervous system as upon the blood and, secondarily, upon the kidneys. The red corpuscles become shrunken and angular, and the greater part of their hæmoglobin, escaping into the plasma, is converted into **methæmo-**

globin, so that marked dyspnœa is likely to result. The color of the blood is changed to a brownish-red, in consequence of which the skin and mucous membranes become discolored, and if the toxic effect is not too acute, icterus follows, and both hæmoglobin and methæmoglobin are excreted in the urine. It is not known whether the methæmoglobin is a direct result of the reduction of the hæmoglobin by the pyrogallic acid, or whether this action is accompanied by a secondary oxidation. In the kidney the poison sets up an inflammatory process, which is indicated by the presence in the urine of albumin, epithelium, casts and the products of blood-decomposition, and which may lead to the production of uræmic convulsions. Pyrogallol is excreted in the urine partly as an ethereal combination with sulphuric acid and partly as unknown oxidized products, which give the secretion a dark brown or black color. When the result is fatal, death appears to be due to the changes in the blood and nephritis resulting therefrom, rather than to any direct effects of the drug on the central nervous system. In dogs poisoned by it, it is said, hepatic lesions are produced identical with those caused by phosphorus. Poisoning, it has been shown by experiment, may readily take place by cutaneous absorption. The mineral acids act as antidotes to its effects. Pyrogallol precipitates albumin, and has a deep and strong local **irritant** action. In a 1 or 2 per cent. solution it is decidedly **antiseptic.** When it is applied in solution or ointment, it **stains** the skin, but not permanently; linen and clothing are, however, permanently darkened. To avoid the staining it has been proposed to dissolve the remedy in flexible collodion, 1 or 2 to 24. Its incautious application may cause inflammation of the skin, which may result in extensive ulceration and sloughing.

THERAPEUTICS OF PYROGALLOL.

It is rarely given internally, and is almost exclusively used in the local treatment of various diseases of the skin. It should not be applied over too large a surface, on account of the danger of absorption, and fatal cases have occurred from the free use of an ointment on extensive cutaneous lesions. Consequently, chrysarobin has been recommended and more or less extensively employed as a substitute for it. The curative effect of pyrogallol in skin affections is usually attributed to its irritant and antiseptic properties, but is referred by some to its reducing action. It undoubtedly has very considerable germicidal power. It may be employed either in the form of an ointment, or dissolved in flexible collodion or alcohol with the addition of a little glycerin. Jarisch's ointment (1 to 8) is entirely too strong for ordinary use; 1 or 2 parts (or even less) of pyrogallic acid to 48 of lard or lanolin will generally be found more satisfactory. Psoriasis, pityriasis versicolor, ringworm, ulcer, sloughing phagedæna, and syphilitic lesions of the integument are among the affections in which it has proved of value. It has also sometimes been used with good effect in such serious diseases as lupus, leprosy and epithelioma. Before pyrogallol is employed vaseline should generally be thoroughly applied, and wiped off, to remove scales and other morbid products. In some conditions it is recommended that the remedy should be mixed with a powder, such as kaolin or starch, and dusted over the affected part.

GAMBIR.

GAMBIR.—Gambir. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Tinctura Gambir Composita.**—Compound Tincture of Gambir. **Dose, 4 c.c. (1 fl. dr.).**
2. **Trochisci Gambir.**—Troches of Gambir.

ACTION OF GAMBIR.

Gambir is a powerful **astringent.** It owes its astringent property to the tannic acid entering into its composition, and aside from this has no special action.

THERAPEUTICS OF GAMBIR.

The compound tincture is a favorite remedy in diarrhœa arising from various causes. If there is any source of irritation in the intestinal tract, or if a considerable quantity of mucus in the discharges indicates a catarrhal condition of the bowel, its administration should be preceded by a purge, such tincture is considered one of the most efficient means of combating the atonic diarrhœa resulting from the disuse of opium or morphine. Owing to the tendency of its gummy matter to coagulate, it is less eligible than gambir for use in connection with chalk mixture. It is often serviceable in relieving pyrosis. Locally kino has not, as a rule, been found as efficient as a hæmostatic as tannic acid. The tincture is sometimes applied as a stimulant dressing to indolent ulcers, and is also employed in astringent gargles and in mixtures for injection in gonorrhœa.

LOGWOOD.

HÆMATOXYLON.—Hæmatoxylon. (Logwood.)

Preparation.

Extractum Hæmatoxyli.—Extract of Hæmatoxylon. **Dose, 1 gm. (15 gr.).**

ACTION OF LOGWOOD.

Hæmatoxylon is **astringent** and tonic. When chewed it colors the saliva a deep pink. It is unirritating, and does not cause constipation. It colors the urine and stools red, and also stains linen with which it comes in contact. It is very feebly antiseptic.

THERAPEUTICS OF LOGWOOD.

In the treatment of diarrhœa it may be combined with other astringents, with chalk, and with opium to check peristalsis. On account of its being pleasant to take and devoid of irritating qualities, it was formerly employed to a considerable extent in children's diarrhœas; but its liability to stain the clothing rendered it objectionable, and of late it has been but little used, especially since the general adoption of dietetic and antiseptic methods in these affections. It is considered of decided value, however, in tuberculous diarrhœa and diarrhœas of relaxation. The following formula will often be found efficient, as well as agreeable to the patient: Extract of hæmatoxylon, 8; aromatic sulphuric acid, 12; paregoric, 45; syrup of ginger, to 120. Dose, a teaspoonful, properly diluted. Externally, logwood is said to display some antiseptic and healing qualities in the treatment of gangrenous and ill-conditioned sores, and a decoction made from it may be used as an astringent in leucorrhœa and bleeding piles.

WITCHHAZEL.

HAMAMELIDIS CORTEX.—Hamamelis Bark. **Dose, 2 gm. (30 gr.).**

Preparation.

Aqua Hamamelidis.—Hamamelis Water. **Dose, 8 c.c. (2 fl. dr.).**

HAMAMELIDIS FOLIA.—Hamamelis Leaves. **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Hamamelidis Foliorum.—Fluidextract of Hamamelis Leaves. **Dose, 2 c.c. (30 ♏).**

ACTION OF WITCHHAZEL.

Hamamelis, containing as it does, a considerable proportion of tannic acid, is **astringent** and **hæmostatic.** Although extravagant claims as to the powers of this drug have been made from time to time, no experimentation has shown that it has any physiological action beyond that which might be expected from an agent rich in tannin. That it has a special influence over the venous circulation, analogous to that of aconite on the arterial system, as believed by some, has never been proved. In full doses it is said to sometimes produce severe throbbing pain in the head.

THERAPEUTICS OF WITCHHAZEL.

Witchhazel is used internally to a very limited extent, notwithstanding the fact that certain authorities claim that its combined internal and external administration is of great efficiency in a variety of conditions, such as hæmorrhoids (particularly of the bleeding variety), varicose veins and ulcers, varicocele, venous congestions, threatening local inflammations, leucorrhœa, and subacute gonorrhœa. Internally, they would have us believe, it is of great service in hæmorrhages from the nose, stomach, lungs, rectum, uterus and kidneys, in purpura hæmorrhagica, in diarrhœa, enteritis and dysentery, in pyelitis and cystitis, in chronic bronchitis attended by copious discharge and the night-sweats of phthisis, in phlegmasia dolens, and in dysmenorrhœa and threatened abortion. When so much is claimed for a remedy one cannot but feel somewhat skeptical as to its real efficacy, and the mass of the medical profession is by no means as yet convinced that it is such a panacea. Externally, hamamelis is believed to have a sedative as well as astringent action upon congested or inflamed tissues, and an extract distilled from the fresh leaves (hazeline), especially, constitutes a useful and agreeable application in a considerable variety of conditions. Thus, it is used for sprains, bruises, and superficial inflammations, and, diluted, in inflammations of the gums, pharyngitis and nasal catarrh. Hamamelis is also employed locally in the form of the fluidextract of the leaves and as an ointment (1 to 10, made from the fluid-extract). The former, diluted, may be injected into the bladder in cases of catarrhal inflammation or hæmorrhage, and is commonly efficient in the treatment of capillary hæmorrhage from wounds, epistaxis, spongy gums, bleeding sockets after the extraction of teeth, and bleeding piles. It is also used as a lotion for freckles, hyperidrosis, carbuncle and lupus erythematosus, and to relieve the pain and stiffness of chronic rheumatism. The ointment is recommended in burns, erysipelas, eczema, herpes, seborrhœa, acne and rosacea, intertrigo and sunburn, as well as in ulcers of the anus or rectum and fissures of the anus. A preparation of witchhazel in popular use is known as Pond's extract. It is said to be made by distilling the bark with very weak alcohol (6 per cent.), and no doubt owes its reputation more to the extensive manner in which it has been advertised and to the credulity of the public than to any virtue that the remedy possesses. The official Aqua may be used for the same purposes.

RHUS GLABRA.

RHUS GLABRA.—Rhus Glabra. (Sumach.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Rhois Glabræ.—Fluidextract of Rhus Glabra. **Dose, 1 c.c. (15 ♏).**

ACTION OF RHUS GLABRA.

Sumach fruit is **astringent** and refrigerant.

THERAPEUTICS OF RHUS GLABRA.

The fluidextract, when diluted, affords a simple and quite effective gargle for inflammation and ulceration of the throat. It is also of service in the treatment of aphthæ and other forms of stomatitis, including that produced by mercury. The glandular excrescences on the leaves are powerfully astringent, and a decoction made from the leaves or the inner bark of the root may be used for the same purposes, as well as for a wash and dressing for wounds and ulcers. An infusion of the strength of 1 to 16 is also sometimes employed. Internally these preparations may occasionally be found of service in mild catarrhal affections of the stomach and bowels.

GERANIUM.

GERANIUM.—Geranium. (Cranesbill.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Geranii.—Fluidextract of Geranium. **Dose, 1 c.c. (15 ♏).**

ACTION OF GERANIUM.

Geranium is one of the best indigenous astringents, and, on account of the absence of unpleasant taste and irritating qualities, it is well adapted for use in the case of children and persons with very delicate stomachs.

THERAPEUTICS OF GERANIUM.

It is very useful in diarrhœa and dysentery, and also in the various hæmorrhages, as an application to indolent ulcers, as an injection in gonorrhœa, gleet, leucorrhœa, fissures of the anus, etc., and as a gargle in relaxed or ulcerated conditions of the throat. In catarrhal inflammations the decoction is not infrequently more serviceable than a simple solution of tannic acid, which is thought to be probably due to the fact that there is present mucilaginous material, which acts as a demulcent.

BLACKBERRY.

RUBUS.—Rubus. (Blackberry.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Rubi.**—Fluidextract of Rubus. **Dose, 1 c.c. (15 ♏).**
2. **Syrupus Rubi.**—Syrup of Rubus. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF BLACKBERRY.

The preparations made from blackberry root are slightly astringent.

THERAPEUTICS OF BLACKBERRY.

These preparations are used for diarrhœa; blackberry brandy is a common domestic remedy. The most efficient one, however, is the fluidextract. The fruit, either raw, cooked or preserved, has no astringent quality, and is only likely to prove injurious, since the hard seeds serve to increase the intestinal irritation.

LEAD SALTS.

1. **PLUMBI OXIDUM.**—Lead Oxide. (Litharge.)

Preparations.

1. **Emplastrum Adhæsivum.**—Adhesive Plaster.
2. **Emplastrum Plumbi.**—Lead Plaster. (Diachylon Plaster.)
3. **Unguentum Diachylon.**—Diachylon Ointment.

2. **PLUMBI ACETAS.**—Lead Acetate. (Sugar of Lead.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Ceratum Plumbi Subacetatis.**—Cerate of Lead Subacetate. (Goulard's Cerate.)
2. **Liquor Plumbi Subacetatis.**—Solution of Lead Subacetate. (Goulard's Extract.)
3. **Liquor Plumbi Subacetatis Dilutus.**—Diluted solution of Lead Subacetate. (Lead Water.)

3. **PLUMBI NITRAS.**—Lead Nitrate.

4. **PLUMBI IODIDUM.**—Lead Iodide.

Action of Lead Salts.

External.—Upon the unbroken skin the salts of lead have little or no action, though the integument is discolored by the use of some of them. Upon denuded surfaces they have a decided **astringent** effect, causing the **contraction** of the small **blood-vessels**, and in the case of ulcers coagulating the albumin of the discharge and the protoplasm of the neighboring superficial cells; in consequence of which a protective coating is formed for the healthier structure beneath. In addition, by reason of the local depletion resulting from vaso-constriction and also, it is thought, because of a depressant effect upon the sensory nerve-endings, they have a marked **sedative** action. Any of these salts, if sufficiently concentrated and applied in sufficient amount, may be irritant and to a certain extent corrosive.

Internal. *Alimentary Canal.*—From the mouth downward the lead salts have the same powerfully astringent effect upon the mucous membrane of the alimentary tract as upon the abraded skin. While they may occasion sufficient corrosion to be absorbed, this absorption never appears to be of sufficient extent to produce acute fatal poisoning from systemic effects. Almost the only result caused by ordinary doses is constipation. When given in large amounts they act as gastro-intestinal irritants, causing salivation, thirst, difficult of swallowing, abdominal pain, vomiting and diarrhœa. There is a burning, sweetish taste in the mouth, and the vomited matter consists of whitish fluid containing curdy material, the color being due to the formation of lead chloride from a combination of the excessive lead with the hydrochloric acid of the gastric juice. In consequence of the astringent action of lead salts, the purging is not as marked as in the case of most irritant poisons, and sometimes there is constipation. If the bowels are moved, the passages are likely to be of a blackish hue from the presence of lead sulphide, and both the stools and the matters vomited may contain blood.

Absorption and Excretion.—In whatever form or whatever doses lead is given, a small quantity is promptly absorbed, and while this may be incapable of producing any immediate symptoms, its excretion is very slow, and consequently cumulative action is liable to result. Lead has been shown to be always absorbed in the form of soluble proteid combinations, and these may be formed from lead compounds which are perfectly insoluble in water or acids. Even lead sulphate, one of the most insoluble of substances, will be absorbed in sufficient amount to produce poisoning, and hence, as previously mentioned (*see* p. 309), sulphuric acid is of comparatively little value as a prophylactic in those exposed by their work to the action of lead. Lead is excreted in the secretion of the intestinal epithelium, the urine, bile, saliva and milk, and probably by the glands of the skin. Chronic lead-poisoning may sometimes be detected, it is said, by painting the integument with ammonium sulphide, which under these circumstances stains it black from the formation of lead sulphide. In the form of the sulphide the lead is sometimes deposited on the edge of the gums, giving the characteristic "lead line," which is also known as Burton's line. This is due to the presence of hydrogen sulphide produced by the action of bacteria, and is not often met with where the teeth are sound and kept clean. In the kidneys lead causes decided irritation during the process of excretion; so that nephritis is found to be a frequent result of acute poisoning and an invariable one of chronic poisoning. A remarkable circumstance in connection with lead-poisoning is the frequency of gout in its subjects. It is asserted by those who have had the largest experience with this disease that in one-fourth of the cases there is a history of saturnism; so that it would appear that the latter predisposes to gout, if it does not actually cause it. In districts where ordinary gout is rare, however, it is said that lead-poisoning seldom leads to it. The nephritis of chronic poisoning is sometimes, no doubt, in part secondary to this disease. It may also be in part secondary to the arteriosclerosis resulting from fatty degeneration of the blood-vessels induced by the lead. Fatty degenerations are likewise found in the kidneys, liver, and other organs. The lead which is retained in the body is stored in the liver, kidneys, brain, bones and muscles, but chiefly in the liver. Only traces of it are found in the blood.

Blood.—In chronic lead-poisoning there is always anæmia, which is due at first to the constriction of the peripheral vessels and subsequently to diminution of hæmoglobin and the number of red corpuscles. The white corpuscles are generally, though not invariably, increased. Not infrequently jaundice results from the breaking up of red corpuscles and the liberation of large amounts of hæmoglobin.

Nervous System and Muscles.—In what is known as *encephalopathia saturnalis* the disorders met with are for the most part of cerebral origin, although the lower divisions of the central nervous system are sometimes also involved. Upon the cortex, which is chiefly affected, there is produced an irritation, followed by paralysis, and the effects are both sensory and motor, the latter being the more pronounced. There are usually muscular contractures and then choreic movements. In some instances convulsions occur, and these are sometimes due to uræmia resulting from the nephritis, and sometimes to the lead itself. Later, paralysis succeeds the motor stimulation. In addition, there is delirium, followed by depression and finally by coma, and the latter may also be uræmic. In autopsies of some of the patients dying from lead-poisoning atrophy of parts of the cerebrum or hæmorrhages, as well as disease of the blood-vessels, has been observed. In prolonged cases of lead-poisoning degenerative changes may occur in the anterior columns of the spinal cord. On the motor system the effects produced are neuritis, paralysis and atrophy. Their usual seat is no doubt in the peripheral nerves and muscle cells, though the central nervous system would appear to be involved in some instances. In chronic poisoning in animals there is early muscular fatigue, which is followed by paralysis, and later by total atrophy. The heart is liable to be similarly affected, and even quite early in the poisoning; especially if the lead-salt is injected directly into the blood. The effect upon the motor peripheral nerves is believed to be very much like the direct muscular action. A common characteristic of lead-poisoning is the "drop wrist" or "painter's palsy," and this is probably attributable in part to paralysis of the extensor muscles and partly to the active contracture of the opposing flexor muscles. The most prominent of the peripheral effects is **lead colic**, a phenomenon which is due to violent contraction of the intestinal muscles, probably from stimulation of the nerve endings. As it is largely relieved by nitrites and other agents which dilate the blood-vessels, it is inferred that a primary vaso-constriction is one of its causes. As the spasm of the intestine forces the blood out of the splanchnic area, the general blood-pressure is raised and the pulse is slowed and rendered hard and tense. The pain, which is intense and grinding in character, is located principally in the umbilical region, and the abdomen is retracted and hard. Paroxysms of the most acute agony are followed by intervals of comparative ease. The colic lasts for several days, or a week, and then disappears, but is apt to recur at intervals. Other affections, apparently, of the peripheral nerves are anæsthesia of various parts, lasting perhaps one or two weeks, and lead arthralgia, which consists of sharp lancinating or boring pains in the joints, bones, or the flexor muscles around the joints, and which generally appears and disappears quite suddenly. Neuralgias are occasionally observed, and these are probably sometimes due to peripheral neuritis and sometimes of central origin. One of the rarer phenomena of lead-poisoning is amblyopia, in which the sight may be lost entirely or only rendered somewhat dim. This may be due to optic neuritis (which, unless arrested early, leads to atrophy of the nerve), to uræmia with an effusion into the optic sheath, or to albuminuric retinitis.

Uterus.—Lead is very fatal to the life of the fœtus, and under its influence abortion is liable to occur, or the child be still-born. It has been suggested that this result is probably due, in part at least, to the poor quality and diminished quantity of the blood supply.

THERAPEUTICS OF LEAD SALTS.

External.—Lead salts, in the form of lotions and ointments, are used, for both their sedative and astringent action, in a great variety of acute local inflammations. A very serviceable preparation is the glycerite (lead acetate, 10; lead oxide, 7; glycerin, 40; water, 24; boiled together), which should ordinarily be diluted fourfold with glycerin or milk. The Liquor Plumbi Subacetatis is sometimes successful in aborting a felon. For most other purposes it is apt to be too irritating, but the diluted solution, as well as the cerate of lead subacetate (which should also usually be diluted), may be applied with advantage to contusions, acute eczema, erysipelas, and inflammations of various kinds. The solution may also be employed to allay itching in such affections as urticaria, paræsthesia, etc. A lotion of lead and opium has long been a favorite application for relieving pain and inflammation. It may be prepared by mixing extract of opium, 1, with 100, each, of lead water and water, or may be made as follows: Solution of lead acetate, 15; tincture of opium, 30; distilled water, 120. Lead lotions, to which zinc sulphate is often added, are used for injections in gonorrhœa, gleet, vulvitis, leucorrhœa and otorrhœa. They were formerly also employed in conjunctivitis, but have been abandoned as applications for the eye; for if ulceration of the cornea be present, the white precipitate formed is liable to lead to permanent opacity. White-lead paint is a good application for burns and scalds where the skin is unbroken, and lead carbonate, mixed with olive oil and with the addition of a few drops of creosote, is recommended for bruises, especially when the surface has a blue or dark discoloration, and for erysipelas and burns. The following is an efficacious dusting-powder in acute eczema, herpes and seborrhœa: Lead carbonate, 24; zinc carbonate, 30; oil of eucalyptus, 1. Diachylon ointment is useful in seborrhœa, hyperidrosis, eczema, dermatitis, herpes zoster, and sycosis. Hebra's diachylon ointment is made by melting equal parts, by weight, of lead plaster and flaxseed oil; to which balsam of Peru and a little oil of lavender are sometimes added. Even in chronic diseases of the skin lead salts are often of service on account of their soothing and astringent effects. Lead plaster is excellent for preventing bed-sores and as a basis for other plasters, and is used by surgeons to protect parts of the body exposed to chafing by splints or other apparatus. A two per cent. solution of lead nitrate in glycerin is a very efficient application for fissured nipple, care being always taken to thoroughly remove all traces of it before the child is allowed to nurse. The nitrate, in very dilute solution, may be used also as a wash in leucorrhœa and to correct the fetid odor of discharges from ulcers, etc. Lead acetate, on account of its astringent action, is occasionally employed for mouth-washes and gargles, but other agents are ordinarily preferred for these purposes. In hæmorrhoids, when there is much pain and a sense of burning heat at the anus, the addition of lead water to the ointments frequently used in such cases often affords marked relief.

Internal.—Lead iodide, it is said, has been given in order to reduce enlargement of the spleen due to malaria. Practically, however, the only lead salt which is used for internal administration is the acetate, which is highly prized for its astringent and hæmostatic effects. It has been largely employed for the purpose of arresting hæmorrhage from the lungs, but is more especially adapted to the hæmatemesis accompanying gastric ulcer. In this affection it is also a very useful remedy in other ways; not only relieving pain, but modifying the ulcerated surface and checking inflammatory action as well. It is likewise of service in chronic catarrh of the stomach, with gastralgia and pyrosis. Theoretically it is incompatible with preparations of opium, but, notwithstanding this, it is very often advantageously combined with them in painful affections of the stomach, as well as in various forms of diarrhœa. It is in the latter that lead acetate is most frequently used, and it is also relied upon for controlling intestinal hæmorrhage, such as is liable to be met with in typhoid fever and tuberculosis. For these purposes a very satisfactory preparation is Pilula Plumbi cum Opio (not official): lead acetate, .20 gm. (3 gr.); opium, .06 gm. (1 gr.). In choleraic diarrhœa, powders consisting of lead acetate, opium and camphor may be employed, or a mixture in which the acetate is associated with acetic acid and tincture of deodorized opium. For the diarrhœa of typhoid, bismuth is usually preferable to lead acetate and opium. In rectal hæmorrhage from various causes and in both acute and chronic dysentery the last-named remedies are of great service when employed locally, either by suppositories or enemata, and the following enema will be found useful in relieving the tenesmus of acute dysentery: lead acetate, 8; morphine acetate, 1; hot water, 960. Although now prescribed comparatively rarely in hæmoptysis, lead acetate seems in some cases to act quite efficiently, and in this condition, as well as in caseous pneumonia, it has sometimes been combined with digitalis and opium. It is of some value in checking the night-sweats of pulmonary tuberculosis, and diminishes the copious secretion sometimes accompanying chronic bronchitis. It is open to the objection, however, of causing constipation.

If lead acetate is administered for any length of time there is more or less risk of plumbism being induced, and some persons are peculiarly susceptible to the poisonous action of the drug. Its effects should therefore always be watched with care. Even the external application of lead solutions or ointments have occasionally been attended by colic and other untoward symptoms.

TOXICOLOGY.

Acute Lead Poisoning.—The acetate is most frequently taken, and a very large quantity of it is required to produce a fatal effect. Owing to the fact that so much of the drug is generally vomited, cases of acute poisoning rarely terminate fatally. The gastro-intestinal symptoms have already been described. They are followed by great weakness, coldness of the surface, and collapse. In some cases in which recovery took place the patients have been known to suffer from chronic lead poisoning, but it has been pointed out that, apart from these, nothing in the course of the acute poisoning suggests the absorption of lead; all the symptoms being obviously due to the local effects on the alimentary tract, and to the subsequent collapse. *Post-mortem.*—In the stomach and intestine such signs of irritant poisoning as redness, excoriation and softening are found.

Treatment.—The stomach should be washed out or emetics (*see* p. 159) given. The precipitation of the lead should then be attempted by the administration of sodium or magnesium sulphate, or, if such sulphates are not procurable, by white of egg or milk, forming an insoluble albuminate. If collapse is present, it should be combated by the administration of stimulants, by hypodermatic injection or by the mouth, and the external application of warmth.

Chronic Lead Poisoning.—This is so common that the sources of accidental poisoning should be borne in mind. The most important are: soft water, carbonated waters and alcoholic drinks (beer) which have passed through lead pipes or been stored in receptacles lined with lead. The occupations of painters (*colica pictonum*), plumbers, typesetters, gold miners, white lead workers, potters, glaziers (Devonshire colic), because the men will not wash their hands before meals nor use ordinary care; lead hair dyes and face powders, biting leaded white thread, eating certain canned fruits (lead solder), sheet-lead (tin-foil) about tobacco, filling holes in mill stones with lead, playing with tin (lead) soldiers by children, use of lead carbonate ointment on burns, lead bullets in flesh, white or red lead used for preparing rubber for vulcanizing, lead plates in dentistry, the use of lead chromate to color buns yellowish, have all been followed by chronic plumbism. Most of the symptoms and effects have been mentioned. Not only the extensors of the hand, but any muscle may be paralyzed (sometimes almost all the muscles of the body seem to be affected), and it is a clinical observation that such muscles are very refractory to electricity. The supinator longus, however, usually escapes, the reason for this apparently being that the supinator is not an extensor muscle. Lead is regarded as perhaps the best example of a poison which is comparatively free from danger in a single dose, however large, but which becomes fatal in the most minute doses, if these are taken for a sufficiently long time.

Treatment.—The first thing to be done is the removal of the patient from the danger of further poisoning. In the general treatment reliance is placed upon potassium iodide, saline purgatives, diuretics, and the use of hot baths and massage to promote elimination, and the improvement, by appropriate measures, of the patient's nutrition and strength. Potassium iodide is universally employed, and appears to have a remedial effect, though the manner of its action is not clearly understood. It has generally been supposed to accelerate the elimination of the poison by the kidneys, but recently it has been denied that it has any influence on the excretion either by the urine or by the intestine, by which most of the lead escapes from the body. Baths of sulphurated potassa are quite efficient, especially if the patient is afterwards well soaped, then thoroughly rinsed off, and finally rubbed down with a rough towel. For the various effects of lead in the system special treatment is required. For the colic, opium or morphine is often necessary, alum, in .12 gm. (2 gr.) doses, is of great service, and sulphuric acid is also useful (*see* p. 309). In a considerable number of cases of chronic lead poisoning it is found that cathartics fail to act unless morphine is given to overcome the intestinal inhibition produced by the irritation resulting from the lead. Opiates may also be required for the relief of the arthralgia. For the paralysis strychnine may be used, but the main reliance is to be placed on electrical stimulation and massage. If the muscles contract in response to the faradic current, this should be employed, but if they do not, the galvanic current. Nephritis and gout due to plumbism should be treated in the same way as if resulting from other causes, while the cerebral symptoms must be dealt with according to the special manifestations present.

The following method may be employed to determine the presence of lead in the urine: Administer potassium iodide for four days, in the meanwhile collecting the urine. Evaporate the latter to 500 c.c. (1 pint), and filter. Pass hydrogen sulphide gas through the urine thus concentrated, when a black precipitate will form if lead is present. Other substances give a black precipitate with hydrogen sulphide, but none such is likely to be present in the urine. A simple test for lead in the system is to paint a small area of skin with a six per cent. solution of sodium sulphite. If lead is present the painted area will darken after a few days. Patients using face enamels containing lead will find the skin blackened on taking baths in water containing hydrogen sulphide (Richfield Springs).

Prophylaxis is of the greatest importance, and the public should be more generally instructed in regard to the insidious dangers of lead. Special precautions are required in lead works and paint factories, and in exposed trades. Dust should be avoided as much as possible, and where this is necessarily present, thorough ventilation of the rooms should be insisted upon. The necesssity of frequent bathing and of thorough washing before meals ought to be impressed upon the workmen. Food should not be permitted upon the premises, and the clothing should be changed before leaving the works. The habitual employment of milk in large quantity as a food has been recommended as of service. Sulphuric acid lemonade is quite generally made use of as a prophylactic, but little reliance can be placed upon it. Weak and anæmic men ought not to be admitted as operatives in lead factories, and it is advisable that women should not be employed at all in them.

SILVER SALTS.

1. **ARGENTI NITRAS.**—Silver Nitrate. **Dose, 0.010 gm. = 10 milligm. (⅙ gr.).**

Preparations.

1. **Argenti Nitras Fusus.**—Moulded Silver Nitrate. (Lunar Caustic.)

2. **Argenti Nitras Mitigatus.**—Mitigated Silver Nitrate. (Mitigated Caustic.)

2. **ARGENTI OXIDUM.**—Silver Oxide. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

3. **ARGENTI CYANIDUM.**—Silver Cyanide.

Unofficial Preparations.

Argenti Citras.—Silver Citrate. (Itrol.)

Argenti Lactas.—Silver Lactate. (Actol.)

Argentum Colloidale.—Colloidal Silver. **Dose, .01 gm.; ⅙ gr.**

Argoninum.—Argonin. (Silver Caseinate.)

Argyrolum.—Argyrol. (Silver Vitellin.) **Dose, .30 to .60 gm.; 5 to 10 gr.**

Protargol.—Protargol.

Action of Silver Salts.

External.—The local action of silver salts is in general similar to that of lead salts—**astringent** and **hæmostatic**—but they are more **irritant** and **corrosive,** especially the nitrate. The astringent effect produced by them is due to the formation of a protective layer of albumin. While dilute solutions of the nitrate may possibly have some vaso-constrictor effect, if the salt is applied in sufficient strength to induce irritation, the blood-vessels will become dilated in consequence of this. Even in dilute solution silver is apt to be slightly irritating to the skin, producing redness and itching, while stronger solutions vesicate, and the solid nitrate causes an eschar. This is at first of a whitish color, but later turns black from the reduction of silver in light. The corrosive action of silver is less deep than that of some other metals, as its penetration is interfered with by the precipitation of silver albuminate. On abraded surfaces and mucous membranes dilute solutions act as astringents, but concentrated ones are irritant and caustic. The silver salts possess very considerable antiseptic power, and, like other astringents, they tend to diminish suppuration by rendering the walls of the blood-vessels less permeable to inflammatory products. At the same time, they tend to prevent the further penetration of bacteria, and hinder their development by rendering the culture-ground unsuitable. Silver nitrate not only coagulates the proteids of the micro-organisms, but is also **antiseptic** from the specific effects of the metal, as is shown by the fact that silver albuminate is likewise an active disinfectant.

Internal.—Unlike the lead salts, those of silver appear to have no astringent action when administered internally. In the stomach the soluble salts are probably converted into the chloride and albuminate, though the form in which the metal is absorbed is uncertain. As it is reduced to the inactive metallic state soon after entering the body, the use of silver does not lead to general poisoning. When it is given for prolonged periods, however, a slight proportion of the metal ingested is absorbed, this absorption being shown by a **pigmentation** of the skin and mucous membranes (argyria). Such discoloration is due to the deposit of minute granules which were formerly supposed to consist of metallic silver, but which are now thought to be an organic compound. They are found also in many internal organs, but are chiefly present in the connective tissues of the body. Argyria may result from the prolonged use of silver nitrate solution as a local application to the eye, nose and throat. In man this pigmentation appears to be the only evidence of absorption. It is believed that most of the silver passes through the alimentary canal unabsorbed, and that none of the very small proportion which is taken up is eliminated; the entire amount remaining imbedded indefinitely in the tissues. In animals, however, some is excreted by the epithelium of the alimentary canal. When silver is introduced into the circulation by subcutaneous or intravenous injection, its effects are found to differ from those of other metals in the predominance of nervous symptoms. In mammals the action is chiefly upon the central nervous system, and especially the **medulla oblongata,** as shown by a rise of blood-pressure and slowing of the pulse, in consequence of increased activity of the vaso-motor and vagus centres. This stimulation is followed by paralysis; the blood-pressure falling, and the respiration becoming slow and labored and then failing altogether. The heart is comparatively unaffected, and may continue to beat for some time after the respiration has ceased. There is also motor paralysis, beginning in the lower extremities. The secretion of bronchial mucus may be so markedly increased that it may lead to asphyxia, and this is thought to be due to injury to the epithelium. In cold-blooded animals violent convulsions, resembling those from strychnine and followed by paralysis, have been observed. Silver nitrate, in solid form or concentrated solution, is a **gastro-intestinal irritant** and corrosive.

THERAPEUTICS OF SILVER.

External.—Silver foil, or metallic silver in very thin sheets, is used as a surgical dressing for wounds and burns. It constitutes a protective covering which may be painlessly removed and renewed and which prevents or curtails suppuration. It is also said to reduce shock. Silver nitrate is in universal use as a caustic whenever a limited and clearly defined action is required, but is of no value for producing a deep or extensive escharotic effect. It is often applied to the bites of dogs and other animals, but it is a dangerous caustic to employ in deep bites, for the pellicle of silver albuminate retains the poison in the wound. The solid nitrate is used also to destroy warts and other growths, to restrain the bleeding from leech-bites, and as an application for ulcers of the mouth, rectum and other parts, for venereal sores, and in catarrh of the cervix uteri. It is said to be of service when applied to the scrotum in acute epididymitis or orchitis, and in lymphangitis of the forearm from a poisoned wound of the finger, if applied along the course of the affected vessels. In erysipelas the disease may sometimes be arrested, it is claimed, by delimiting the affected area with silver nitrate. Boils or a stye on the eye have been aborted by its early use, and it has also been employed with good results in eczema, lichen, herpes and other cutaneous affections when occurring in circumscribed patches. For tinea tricophytosis a solution in nitrous ether (1 to 12) may be used. The mitigated caustic is a good application to granular lids, chancroids, small-pox vesicles (to prevent pitting), and in general to excite a healthy action of granular surfaces. The injection of a strong solution of silver nitrate in the early stage of the disease has been advocated by some as a method of aborting gonorrhœa. Buboes have been successfully treated by the injection, after puncture, of a 2 per cent. solution of the nitrate, and in punctured wounds the injection of a solution of the strength of 1 to 48, after the wound has been disinfected, has been recommended for preventing the development of tetanus. Uniting, as it does, an irritant stimulating, with an astringent, effect, lotions of the salt, the strength of which is usually about 1 to 96 of water, are often of great service as an application for chronic pharyngitis or laryngitis and indolent ulcers, or as an injection in gleet or inflammation of the cervix uteri, while weaker solutions are used for various forms of ophthalmia. Ophthalmia neonatorum is successfully treated by early applications of a 1 per cent. aqueous solution of silver nitrate. This is commonly known as Credé's method, but the original formula as prescribed by him was double this strength. In spasmodic stricture of the œsophagus the occasional use of a very weak solution by means of a sponge probang may prove of service. A 1 to 24 solution is efficient in pruritus vulvæ and in the prevention of bed sores, and the injection in small quantities of a solution varying from this strength up to one which is three or four times as concentrated into the sac of a hydrocele or cystic tumor has been attended with good results. Irrigation of the bowel with a solution of from 1 to 2 to 96 is often useful in pseudomembranous enteritis, while prolapsed rectum, especially in children, is benefited by cauterization with mitigated silver nitrate.

A useful injection in gonorrhœa is silver caseinate (Argonin, not official) in 1.5 per cent. solution, which causes the speedy disappearance of gonococci, but since this is not astringent, other remedies must be employed to relieve the inflammation. Silver lactate (Actol, not official) is used as an antiseptic in sore throat, gonorrhœa, etc., in a 2 per cent. solution. Silver citrate (Itrol, not official) in 1 to 4000 solution is employed for the same purpose. Protargol (not official), a proteid compound readily soluble in water, is used as an injection for gonorrhœa. The usual strength is 1 per cent.

Silver soluble in water, an allotropic form discovered about 1890, now termed colloidal silver (not official), has been well received and has obtained a permanent place in therapeutics. It is usually employed as a 15 per cent. ointment (Credé) by inunction. It has been used successfully for chronic furunculosis, phlebitis and other septic processes, and, in weak solution (1 in 5,000 to 10,000), for irrigating the bladder.

Argyrol, or silver vitellin (not official), is a recent preparation which is distinguished from other silver salts by the high amount of silver it contains (30 per cent.), its intense penetrating action on the tissues, its freedom from irritating properties, and its power to allay the signs and symptoms of inflammation. In spite of its large percentage of silver, a 20 per cent. solution of argyrol may be dropped in the normal conjunctival sac without producing irritation or discomfort, while the penetrating action of the salt is demonstrated by its action on catgut, a strand of which, after immersion in the solution, is found to be penetrated through and through with the argyrol. Hence it is argued that argyrol will exert the antiseptic effects of silver in the deep submucous structures where, in most pathological conditions, pathogenic organisms find and maintain lodgment in spite of energetic measures to eradicate them. Practically the remedy, topically applied, has proved of service in various diseases of the eye, ear, nose, throat and genito-urinary organs, as well as in a number of surgical conditions. It appears to be especially efficient in the treatment of gonorrhœa (which may sometimes be aborted by it) and of purulent conjunctivitis (of the new born, gonorrhœal, etc.). In trachoma the lids may be painted with a 25 per cent. solution, and a 2 per cent. solution, used by instillation, is said to be a certain prophylactic against ophthalmia neonatorum. It is stated to be the only silver salt which does not permanently stain the conjunctiva. Laryngologists who have employed argyrol in different conditions of the larynx and pharynx report that it seems to be quite as effective as silver nitrate, while it is far more agreeable to the patient. Argyrol has also been used internally, in place of silver nitrate, in the treatment of gastric ulcer, gastritis, gastro-enteritis, etc. It is claimed for it that, taken internally, it is absolutely non-toxic, is not absorbed, and is unchanged in the stomach or intestine; hence, with it, it is possible to secure the local effects of silver directly upon the affected portions of the mucous membrane. It is advised that it should be taken, in doses of .30 to .60 gm. (5 to 10 grs.), in capsules, followed by a glass of water, three times a day.

Internal.—Silver salts were formerly employed to a considerable extent in nervous diseases, in which they were supposed to be in some way efficacious, and the nitrate especially was largely used in the treatment of epilepsy. At the present day its long continued administration is wholly unjustifiable on account of the objectionable discoloration of the skin to which it gives rise, while we have at our disposal other remedies which are far more efficient. Indeed, it seems very unlikely that silver reaches the central nervous system in any other form than inert granules. There are, however, some conditions met with in the alimentary canal in which it is considered of value, and if it is not used too freely, or for too long consecutive periods, there would appear to be little risk of inducing argyria. There is no case on record, it is stated, of the latter having been caused by less than 30 gm. (1 oz.) of silver nitrate. The gums should be examined from time to time, as it has been found that the cutaneous pigmentation is preceded by the development on the edge of the gum of a dark line, which is removable by a course of acid potassium tartrate. On account of the conversion which takes place in silver salts upon reaching the stomach it is somewhat perplexing to explain the remedial action of silver nitrate as an internal remedy, but clinical experience seems to show that it is of service in gastric ulcer and in chronic gastric catarrh and gastritis accompanied with sour eructations or with vomiting after meals. In the treatment of ulcer it is recommended that it should be given in pill form with extract of hyoscyamus or opium. Combined with opium it has been found effective in the diarrhœa of phthisis, and with opium and ipecacuanha, in the diarrhœa of typhoid fever. It has also been employed in other forms of diarrhœa and in dysentery. In intestinal ulceration it has been highly recommended, it being advised that under these circumstances the drug should be administered in hard or keratin-coated pills, in order that it may pass through the stomach without being chemically changed. In ulceration of the cæcum and rectum, as well as in dysentery, rectal or colonic injections of silver nitrate are no doubt preferable. From .60 to 1.20 gm. (10 to 20 gr.) to 500 c.c. (1 pint) of water may be employed for this purpose. For high injections a flexible tube should be used, and the bowel should be washed out with tepid water previous to the introduction of the silver solution. As silver nitrate when given by the mouth is usually associated with opium or other remedies, it would seem open to question whether much of the benefit apparently attending its use in affections of the gastro-intestinal tract may not in reality be due to these other drugs. For use in stomach troubles some prefer silver oxide to the nitrate, on account of its less caustic qualities.

Colloidal silver, which is entirely soluble in water and in albuminous fluids, is unirritating, so that it can be administered hypodermatically and intravenously as well as by inunction, as is mentioned above. For internal use, to prevent its conversion into a chloride in the stomach, it is first dissolved in equal parts of albumin and glycerin. The dose of .01 gm. ($\frac{1}{6}$ gr.) may be given two or three times daily. It is claimed that it has a very beneficial influence and often affords a rapid cure in recent and also in chronic sepsis when secondary changes in the vital organs have not occurred. It seems to inhibit the action of staphylococci and streptococci, or destroy them altogether. It has been used in various conditions: osteomyelitis, so-called gonorrhœal rheumatism, puerperal fever, cerebro-spinal meningitis, and septic processes in general. Thus far no instance of argyria from its use has been reported.

TOXICOLOGY.

The nitrate sometimes causes acute poisoning.

Symptoms.—These are, intense pain in the abdomen and muscular spasm, followed by vomiting and, generally, purging. The face is livid and covered with perspiration. The vomited matter is black and contains coagulated mucus. If the salt is in solution, the mucous membrane of the mouth will be covered with a grayish-white membrane, which afterwards becomes dark-colored. Should the case terminate fatally, the post-mortem appearances are those commonly met with in acute corrosive poisoning. Chronic poisoning or argyria shows itself by a permanent slaty discoloration of the skin, conjunctivæ and labial mucous membrane and ulcerations in the digestive tract.

Treatment.—This consists of administering a solution of sodium chloride (common salt), soothing the mucous membranes by injection of milk, and relieving pain with opium. The chronic form is avoided by interrupting the treatment, using eliminating remedies, and preventing staining of the skin by baths of sodium thyosulphate.

ZINC SALTS.

1. **ZINCUM.**—Zinc.

2. **ZINCI CHLORIDUM.**—Zinc Chloride. (Butter of Zinc.)

Preparation.

Liquor Zinci Chloridi.—Solution of Zinc Chloride.

3. **ZINCI SULPHAS.**—Zinc Sulphate. (White Vitriol.) **Dose** (emetic), **1 gm. (15 gr.).**

4. **ZINCI CARBONAS PRÆCIPITATUS.**—Precipitated Zinc Carbonate.

5. **ZINCI OXIDUM.**—Zinc Oxide. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Unguentum Zinci Oxidi.—Ointment of Zinc Oxide.

6. **ZINCI ACETAS.**—Zinc Acetate. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

7. **ZINCI STEARAS.**—Zinc Stearate.

Preparation.

Unguentum Zinci Stearatis.—Ointment of Zinc Stearate.

ACTION OF ZINC SALTS.

External.—Zinc chloride is an energetic **corrosive.** It causes much pain and penetrates deeply, but is valuable as a caustic for the reason that its action is limited to the seat of application. It is strongly **antiseptic,** and constitutes the chief ingredient of Burnett's fluid, a well-known domestic disinfectant. Solutions of the chloride of moderate strength are excitant, astringent and slightly hæmostatic. The other zinc salts are also **astringent** and mildly **hæmostatic,** thus acting like those of silver and lead, though their action is less powerful. The most active of them are the sulphate and acetate; the oxide, stearate and precipitated carbonate being quite feeble astringents.

Internal.—Zinc chloride is a violent corrosive poison to the alimentary canal, causing a burning pain in the mouth, throat and abdomen, with vomiting and purging, followed by collapse. The matter vomited is likely to contain blood and shreds of mucous membrane, and the stools may also contain blood.

Zinc salts, as a rule, act as astringents upon the gastro-intestinal mucous membrane, as well as upon the abraded skin and ulcerated surfaces. They are believed to have a somewhat specific irritant action, affecting at first exclusively the nerve structures in the stomach which form the starting point of the vomiting reflex; consequently **emesis** occurs before there is time for corrosion, and even very large amounts may be free from danger. The most typical in its action is the sulphate, which in doses of 1 to 1.20 gm. (15 to 20 gr.) is a very prompt emetic. Its action is so rapid that there is no time for nausea, and its depressing effects are also very slight.

Remote Effects.—The general action of zinc salts can be observed only when they are thrown directly into the circulation. Injected intravenously, they appear to depress the central nervous system, and to a less extent the heart and voluntary muscles, and to cause irritation and congestion of the gastro-intestinal mucous membrane, as well as inflammation of the kidney. Emesis is one of the effects produced, and this is thought to be probably due to the inflammation of the stomach induced by the metal, rather than to any direct action upon the medullary centre for vomiting. Zinc has been found to possess a special affinity for the hæmoglobin of the blood, with which it forms a compound (zinc-hæmol), but its administration has no effect on the formation of hæmoglobin. Zinc is excreted by the stomach and intestinal walls, and in much smaller amounts in the bile and urine. Of the zinc absorbed from the stomach and intestine, most is found to be contained in the liver and bile. Less of it is met with in the spleen, kidney, thyroid and pancreas, and very little in the other tissues. It is said that the exhibition of 155 gm. of zinc carbonate, in the course of 335 days, induced no appreciable effects in the dog, and that the continued administration of zinc salts has no effect in man, except those of disordered digestion and constipation. Workers in zinc are occasionally the subjects of what is known as "brassfounders' ague," an affection which is apparently due to the fumes of zinc which escape in the process of casting. After a period of general malaise, followed by prolonged rigors and shivering, soreness of the chest occurs, accompanied by coughing and headache. Then profuse perspiration supervenes and the patient falls into a deep sleep, from which he awakes in ordinary health. A number of obscure nervous conditions have been described as being caused by zinc in those who work with the metal, but they appear to be extremely rare, and when present may possibly be due to arsenic, lead, or other impurities occurring in zinc compounds.

Therapeutics of Zinc Salts.

External.—Zinc chloride is an effective caustic for morbid growths, such as epitheliomata, nævi and condylomata, as well as for gangrenous sores. It may be applied in the form of a pencil made with plaster-of-Paris or of a paste made with starch, flour or dried gypsum. Canquoin's paste is a mixture of zinc chloride in varying strength with wheat flour and water. In malignant disease of the uterus the chloride has been used both in paste and in saturated solution applied by means of a tampon. Injections of zinc chloride (about 1 c.c.; 15 ♏ of a 1 per cent. solution) have sometimes been made into the tissues in the vicinity of the fracture, for the purpose of promoting the union of fractured bones, and in a case of recurrent luxation of the shoulder the tendency to dislocation is stated to have been overcome by a number of injections of .12 c.c. (2 ♏) of a 10 per cent. solution into the anterior superior portion of the capsule below the acromion process. The same plan of treatment has also been applied in tuberculosis of joints and in lupus, and even in the early stages of pulmonary tuberculosis minute quantities of such solutions have been injected into the lung, with the object of favoring the formation of fibrous tissue and thus arresting the disease. Liquor Zinci Chloridi, much diluted, may be employed as a detergent and stimulating application to old sores and as a disinfectant for wounds. Either the Liquor, or Burnett's fluid (which is a somewhat stronger solution), is sometimes used to disinfect fæces, urinals, closets, etc. Platt's chlorides is said to consist of various salts of zinc, chiefly the chloride, in saturated solution. Lotio Rubra, a solution of the sulphate (generally about 1 to 240), colored red with compound tincture of lavender, is used as an astringent application to abraded surfaces, ulcers, etc., and as an injection in gonorrhœa, leucorrhœa, or otitis. Either alone or combined with other agents, zinc sulphate is very commonly employed as an injection in gonorrhœa and gleet and as a collyrium in conjunctivitis. The acetate (.03 to .06 c.c.; ½ to 1 gr.) in rose-water (30 c.c.; 1 fl. oz.) is also useful for the latter purpose. The oxide, stearate and precipitated carbonate, either dusted on the part or in the form of ointment, may be employed in a great variety of conditions where only a mild astringent effect is required. The ointment of zinc oxide is perhaps more widely used than any other as a protective and slightly astringent application in acute skin affections, and to it are frequently added phenol, oil of cade, tar, and various other agents, according to the case, for the treatment of eczema, herpes, erysipelas, burns, etc. What is known as Unguentum Metallorum, which consists of equal parts of the ointments of zinc oxide, lead acetate, and diluted mercuric nitrate, is a serviceable application for some forms of eczema and other skin diseases, as well as for sores and ulcers. For pruritus the following combination is recommended: Zinc oxide, 25; gelatin, 20; glycerin, 60; water, to 480. This compound is to be melted and applied with a brush, after which the part should be covered with cotton. Unna's zinc-glue, which, when rubbed into the gauze or muslin of a bandage, forms a stiff surgical dressing, consists of 10 parts of zinc oxide, and 30 parts each of gelatin, glycerin and water. Good preparations of calamine (purified zinc carbonate), which is efficacious as a mild astringent for cutaneous affections, are the following: An ointment with benzoinated lard (1 to 5) and a lotion consisting of calamine, 3; zinc oxide, 3; glycerin, 4; lime-water, 16; water, 60.

Internal. *Alimentary Canal.*—Zinc chloride is not given internally. The sulphate was formerly much employed to produce vomiting in cases of croup, but has now for the most part been superseded by other remedies. It is, however, a very serviceable emetic in narcotic and other poisoning, where prompt and efficient action is required. It is quite safe so long as the mucous membrane is intact, for under these circumstances it is not absorbed. Practically, however, it always produces some irritation of the gastric walls, and its use should therefore be limited to cases in which the poison is not injurious to the stomach itself. Its only advantage over apomorphine appears to consist in a less degree of nausea and depression. In doses of .03 to .12 gm. (½ to 2 gr.) it has been found to afford great relief in that form of dyspepsia which gives rise to oxaluria. Both the sulphate and oxide are occasionally given in chronic diarrhœa and dysentery. The oxide is useful in gastralgia, and has been recommended, usually in association with other drugs, when the following conditions are present: pain after eating, nausea, and intestinal pain, succeeded by prompt evacuation of the bowels, the fæces being made up largely of undigested food. In the summer diarrhœa of children it is sometimes administered with bismuth and pepsin, and to diminish the craving for alcohol and relieve the gastric catarrh of drunkards it has been employed in combination with piperin.

Remote Effects.—The preparations of zinc have been thought to exert an antispasmodic influence upon the nervous system, and the sulphate and oxide were formerly employed to a considerable extent in the treatment of such affections as epilepsy, chorea, hysteria and whooping-cough. Their efficacy is doubtful, however, and they have now largely fallen into disuse as nervous depressants. The oxide is of some service in checking the night-sweats of phthisis, particularly when combined with extract of belladonna, but it is quite likely to interfere with the digestion. Trousseau's pill for this purpose consists of zinc oxide, .30 gm. (5 gr.), with extract of hyoscyamus, .06 gm. (1 gr.).

Zinc bromide, iodide, phenolsulphonate and valerate are considered elsewhere.

TOXICOLOGY.

The appearances met with after death from zinc chloride are those which commonly characterize the action of a gastro-intestinal irritant. The sulphate, in large doses, also acts as an irritant poison, producing colicky pains, diarrhœa and prostration.

Treatment.—The salt itself usually produces such prompt and copious vomiting that other emetics are scarcely required, but these may be give (*see* p. 159), or the stomach may be washed out. Demulcents should then be administered: lime-water, mucilaginous drinks, and albumin freely in the form of eggs or milk.

COPPER SULPHATE.

CUPRI SULPHAS.—Copper Sulphate. (Cupric Sulphate. Blue Vitriol. Bluestone.) **Dose** (astringent), **0.010 gm. = 10 milligm.** (⅙ **gr.**); (emetic) **0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF COPPER SULPHATE.

External.—Used in substance, it is somewhat corrosive. In solution it acts like zinc sulphate, but is more strongly **astringent** and **antiseptic.**

Internal. *Alimentary Canal.*—In moderate doses it is a prompt and efficient **emetic,** acting in precisely the same manner as zinc sulphate, though it is more irritant. In large quantities it causes corrosion of the gastro-intestinal mucous membrane, with violent vomiting and purging. In small doses it is markedly astringent.

Remote Effects.—Small amounts may be taken for an indefinite period without giving rise to any appreciable effect, so that the general action of copper salts in man is unknown. In animals their intravenous injection in sufficient quantity induces paralysis of the spontaneous movements and of the heart and respiration, the respiration failing somewhat earlier than the heart. The blood-pressure at first rises, and afterwards falls, in consequence of the failure of the vaso-motor nerves to maintain the contraction of the vessels, as well as from the weakness of the heart itself. According to most observers, no emesis is induced, so that it seems certain that the vomiting resulting from the administration of copper salts by the mouth is due to the gastric irritation, and not to any direct action on the central nervous system. If the animal survives long enough, violent and perhaps bloody diarrhœa is generally observed. Copper is absorbed from the stomach and intestine, and also from other mucous membranes and from wounds, and the metal is stored chiefly in the liver, though it is found in smaller amount in the spleen, kidney and thyroid. It is excreted in the intestinal secretions, bile, urine, saliva and milk, and is said to pass from the mother to the fœtus in utero. It is stated to have a strong affinity for hæmoglobin, forming with it a compound called cuprohæmol, but, like zinc, does not increase the hæmoglobin of the blood. Animals have been fed with food containing considerable amounts of copper for many months at a time without showing any special evidence of poisoning, and this metal, it is said, is found so regularly in the tissues of man and animals that it may be regarded as a normal constituent, although its function is quite unknown and it may be merely stored up on its way to excretion.

THERAPEUTICS OF COPPER SULPHATE.

External.—As a caustic it is milder in action and also less painful than silver nitrate. In solid form or powder it is applied to indolent ulcers and granulations, syphilitic and other sores in the mouth and throat, granular lids, corneal ulcers, etc. In weak aqueous solution it is sometimes employed in subacute conjunctivitis, but the acetate is preferable for this purpose. In place of the pure sulphate, what is known as Lapis Divinus may be used as a caustic. It consists of copper sulphate, potassium nitrate, and alum, each 24 parts, and camphor, 1 part. The camphor is added after the other ingredients have been fused together, and the whole mass is then cast into cylindrical moulds. Lotions of copper sulphate are more strongly astringent than those made with zinc sulphate, but are often employed for the same purposes in the strength of about 1 to 240. In this strength it may be instilled into the eye. Somewhat more concentrated solutions have a mild hæmostatic effect, and the solid salt is also serviceable for checking hæmorrhage from slight wounds, leech bites, and irritable ulcers. Associated with zinc sulphate and lead acetate, or with fluid extract of geranium or other remedies, copper sulphate is used to a considerable extent in gonorrhœa, and weak solutions of it also make good injections for vaginitis, leucorrhœa and gleet, as well as good stimulant dressings for chancres and chancroids. In the strength of from 1 or 2 to 48 of menstruum it is sometimes thrown into the bowel for the relief of chronic diarrhœa and dysentery and of acute diarrhœa of severe form, and a solution of 1 or 2 to 96 in glycerin has been recommended as an injection in pseudomembranous enteritis. An aqueous solution of 1 to 4 may be used with good effect as a gargle in relaxed sore throat and as an application for hyperidrosis or bromidrosis. A solution of 1 to 16 of water is said to be very efficacious in the treatment of scabies, and in weaker solutions and ointments copper sulphate is of service in psoriasis, sycosis and other forms of tinea, acne, chronic eczema, and other skin diseases.

Internal.—As an emetic it is used in the same class of cases as zinc sulphate. As it is more irritant than the latter, the stomach should be promptly evacuated by some other means in any case in which it fails to produce vomiting. On account of its irritant effect some would restrict its use as an emetic to cases of phosphorus poisoning, in which it has been supposed to be particularly serviceable on account of the possible deposition of copper on the particles of phosphorus preventing the absorption of the latter. It is extremely doubtful, however, whether copper sulphate is especially valuable in this way. In acute dysentery it may be given with advantage combined with magnesium sulphate and dilute sulphuric acid, and, after the acute symptoms have subsided, with morphine or opium. Associated with opium, it is a useful palliative astringent in the diarrhœa of phthisis, and of all the metallic astringents in use, it has been pronounced the most effective in chronic diarrhœa and chronic dysentery. It is regarded as indicated when colicky pains and tenesmus are present, and the stools, partly feculent, contain mucus streaked with blood, and it may be given in pill form in doses of .005 gm. ($\frac{1}{12}$ gr.) combined with the same amount of morphine sulphate and .12 gm. (2 gr.) of quinine sulphate. When tolerance of the copper sulphate is established, it is advised that the dose should gradually be increased to .015 gm. (¼ gr.). In gastro-intestinal catarrh also minute doses of it are of service. In some states of the body, particularly in cutaneous affections of the dry type and in persons with tubercular tendencies, it is thought to act like arsenic, and may be given in cases in which that drug is not well borne. It has been used in anæmia and chlorosis, and has also been recommended in the treatment of syphilis.

TOXICOLOGY.

Acute poisoning.—The copper is apt to give a blue or green tinge to the vomit and fæces, and later blood appears in them from the corrosion of the mucous membrane. There is intense abdominal pain, and the usual symptoms of acute corrosive poisoning may follow—collapse, with weak pulse and respiration, cold, clammy skin, dizziness, unconsciousness, delirium, coma, convulsions and paralysis.

Chronic poisoning.—This is a matter of great practical interest. Preserved peas and other vegetables, the green color of which is due to preparation with copper, are in common use by the public. Copper is also added to flour to improve the bread made from it, and it may enter the food from the use of cooking utensils made of this metal and in a variety of other ways. No deleterious effects appear, as a rule, to result from such introduction of copper into the system, and it has been disputed whether chronic copper poisoning occurs in man at all; especially as it is claimed that copper may be taken directly, either in the form of the metal or of its soluble salts, for prolonged periods without the production of any symptoms except perhaps more or less nausea and the evidences of a mild intestinal catarrh. Still, the facts show unquestionably that instances of chronic poisoning are occasionally met with. Among workers in copper and brass the skin and hair not infrequently have a greenish tint, while the upper borders of the teeth may show a green discoloration which is known as the "copper line." In addition, colic and diarrhœa, or acute febrile attacks of gastro-intestinal catarrh, which may be followed by local paralysis, are sometimes observed, and the following symptoms have also been noted: anæmia, wasting, dyspepsia, tremors, headache, vague pains, pharyngeal and laryngeal catarrh with occasional hæmoptysis and aphonia, and profuse secretion of sweat, which may be of a greenish hue. The occurrence of these various manifestations has been attributed in part to the deposit of copper dust upon the skin, hair and teeth, and in part to the lead, arsenic and other poisons often associated with copper. It would seem altogether probable that in a considerable proportion of instances such an explanation will suffice for the symptoms present, but, on the other hand, certain cases come under observation from time to time in which the evidences of chronic poisoning are indisputably due to copper alone.

Treatment.—For acute poisoning give albumin, milk or magnesia. Potassium ferrocyanide is the chemical antidote. Then promptly empty the stomach and saturate the system with potassium iodide. Chronic poisoning is best treated by the administration of fifteen drops of diluted phosphoric acid before each meal, the ingestion of large quantities of milk, and thorough daily evacuation of the bowels with magnesium or sodium sulphate.

ALUMINUM SALTS.

1. **ALUMEN.**—Alum. (Aluminum and Potassium Sulphate. Potassium Alum.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Alumen Exsiccatum.—Exsiccated Alum. (Burnt Alum.)

2. **ALUMINI HYDROXIDUM.**—Aluminum Hydroxide. (Aluminum Hydrate.)

3. **ALUMINI SULPHAS.**—Aluminum Sulphate.

Unofficial Preparation of Aluminum.

Alumnol.—Alumnol. (Aluminum Naphthol-Sulphonate.)

ACTION OF ALUMINUM SALTS.

External.—Aluminum salts in solution are **astringent** and **hæmostatic,** throwing down a layer of precipitated albumin on the surface of mucous membranes and on raw surfaces; also coagulating the albumin in the underlying tissues, and thus constricting the blood-vessels. In concentrated form they act as irritants, and burnt alum, by reason of its marked avidity for water, is somewhat escharotic. On account of their property of precipitating proteids aluminum salts are **antiseptic,** as well as astringent, and in particular the acetate (not official) in saturated solution is a very penetrating antiseptic. In hæmorrhage, when the leaking vessels can be directly reached, alum is a valuable hæmostatic, as it acts in three ways to arrest the bleeding: coagulating the albumin, constringing the parts, and, by crystallizing when applied in large amounts on lint, affording a surface which is rough and aids coagulation.

Internal. *Alimentary Tract.*—They have a purely local action, not being absorbed to any extent from the alimentary canal, and even very large amounts cause only a local exudative inflammation (in consequence of the precipitation of proteids) which is characterized by nausea and vomiting and in extreme cases by purging. In small doses they act as astringents upon the mucous membrane of the mouth, stomach and intestine, and usually cause constipation. In larger doses they are mechanical emetics. On account of the lack of absorption, no symptoms of general poisoning are induced by their internal administration, and their long-continued use is never attended with evidences of chronic poisoning. Locally, however, they have, as has been mentioned, a decided action, and it is probably true that their continued administration in even small doses will produce deleterious effects.

Remote Effects.—The general action of aluminum salts is seen only when they are thrown directly into the circulation. Aluminum, like various other metals, acts on the intestine and kidney, and also appears to have a direct action on the brain. The intoxication is a very slow one, the symptoms appearing only several days after the intravenous injection, at a time when the metal has entirely disappeared from the blood, and has become fixed in the cells. In mammals the first symptoms are observed in from three to five days, and are found to consist in constipation, rapid loss of weight, weakness, torpor and vomiting. Later, marked abnormalities in movement and sensation are noticed, such as tremor, jerking movements, clonic convulsions, paresis of the hind legs, anæsthesia of the mouth and throat, and lessened sensation over all parts of the body. Eventually diarrhœa and albuminuria are generally noted. After death there are found swelling and congestion of the gastro-intestinal mucous membrane, fatty degeneration of the liver and kidney, and hæmorrhages in the cortex of the latter organ; while aluminum is found in the urine. It has recently been shown also that the nerve cells of the spinal cord and medulla oblongata, and particularly those of the lower cranial nerves, undergo degeneration. What little aluminum is absorbed from the alum salts of the food is thought to be rapidly excreted by the intestine and perhaps by the kidney.

THERAPEUTICS OF ALUMINUM SALTS.

External.—Alum is in general use as a local astringent. Thus, solutions of it are applied on lint or injected in the vulvitis of children, and are used as injections in leucorrhœa, gonorrhœa, gleet, chronic cystitis, dysentery, and hæmorrhage from the rectum. Alum, dissolved in infusion of logwood, is often an efficient application for prolapsus of the rectum in children. In powder or strong solution it is serviceable as a styptic for capillary hæmorrhage from wounds, hæmorrhage after tooth-extraction, leech bites, epistaxis, bleeding from the gums, bleeding piles, etc. The topical application of powdered alum is sometimes very useful in chronic pharyngitis, tonsillitis and nasal catarrh, and in ozæna the nasal chambers may be irrigated with a 1 to 16 solution in water. A solution of about the strength of 1 to 96 in water is employed as a gargle, and gargling the throat with alum dissolved in a decoction of barley, to which a small quantity of honey of roses is added, is said to be of service to speakers or singers if practised shortly before using the voice. Alum has been used in solution as a mouth wash for ulcerative stomatitis and mercurial ptyalism, but is objectionable for this purpose, as well as for making gargles, as it attacks the enamel of the teeth. For conjunctivitis an alum curd (2 gm.; 30 gr., of alum beaten up with the white of a fresh egg) is also sometimes applied externally. A solution containing 1 part each of alum, copper sulphate, zinc sulphate, and ferrous sulphate, to 96 of distilled water, to be brushed upon the inside of the lids, once daily, has been recommended in chronic granular conjunctivitis. The local astringent action of alum may be utilized for moist eczema and purpura, and, dissolved in water to which alcohol is added, it may be sponged over the surface for night-sweats or excessive sweating of the feet or hands, or employed to harden the nipples of pregnant women. Alum solutions are also more or less effective in the treatment of bed sores, chilblains, and ingrown toe-nail. In the latter condition a piece of twisted absorbent cotton saturated with a strong solution is inserted under the nail. A hot solution will sometimes relieve pruritus vulvæ, and ointments containing alum are often useful in herpes and bromidrosis. The dried powder is occasionally applied as an escharotic for destroying granulations and warty growths, and is also used to stimulate indolent ulcers and mucous membranes with morbid secretions.

Aluminum naphthol-sulphonate (alumnol, not official), in 1 to 3 per cent. solutions, is an unirritating astringent which, although precipitating albumin, dissolves it when in excess, and therefore penetrates below the surface. It is used for the treatment of acute and chronic inflammations of various mucous membranes.

Internal.—It is said that .60 gm. (10 gr.) of alum, placed upon the tongue, will sometimes arrest a paroxysm of asthma. Not being depressing, alum is a good emetic, especially for children suffering from croup, bronchitis, etc. 4 gm. (1 teaspoonful) of powdered alum, dissolved in syrup, may be given every fifteen minutes until vomiting is produced. As an internal astringent or hæmostatic it is not as a rule as efficient as some other remedies, but in the form of alum whey (milk curdled by alum), it may often be given with advantage in cases of typhoid fever in which the diarrhœa calls for special treatment. In intestinal hæmorrhage when dependent upon mechanical causes, such as cirrhosis, if the mucous membrane is free from acute inflammation, and in hæmatemesis when the hæmorrhage is passive and the gastric mucous membrane relaxed, alum is likely to be of service. It may also be used in catarrh of the stomach, especially where there is vomiting of glairy mucus; a pill containing .24 gm. (4 gr.) of alum and .06 gm. (1 gr.) of extract of gentian being administered three times a day. Alum is one of the most effective of all remedies in the treatment of lead colic, and by many it is considered to relieve the pain and nausea and overcome the constipation of plumbism more certainly than any other agent. Its beneficial action is attributed by some to the fact that, being a sulphate, it precipitates any lead salts present in the intestine as insoluble lead sulphates. Others, however, hold that the chemical theory of its action is entirely inadequate to account for its remarkable effects, believing that the conversion of any portion of the lead present into the insoluble sulphate would not suffice to quiet pain, relieve flatulence, and relax the obstinately constipated bowels. The explanation they bring forward is that its action is doubtless dynamical, being exerted upon the muscular layer of the bowel, on the abnormal condition of which the phenomena of lead colic depend. Still others, finding that alum is of service when there is no lead in the alimentary canal, state that it must act in some way as yet unknown. Being a soluble sulphate, as well as an emetic, alum may also be used as an antidote in acute lead poisoning. In the form of a very fine spray a strong solution of alum, 1 to 24, is sometimes efficacious in hæmoptysis, and such a spray may also be employed in bronchorrhœa and in chronic catarrh of the pharynx and larynx.

(*b*) **Acting generally.**

SUPRARENAL GLAND.

GLANDULÆ SUPRARENALES SICCÆ.—Desiccated Suprarenal Glands. (Suprarenal Extract.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Suprarenal Gland is a vaso-constrictor of the first importance, but will be considered in association with the other Organic Extracts, in Division XIII.

BARIUM SALTS.

Unofficial Preparations.

1. **Barii Chloridum.**—Barium Chloride. **Dose, .006 to .03 gm.; $\frac{1}{10}$ to ½ gr.**
2. **Barii Dioxidum.**—Barium Dioxide. (Barium Peroxide.)
3. **Barii Sulphidum.**—Barium Sulphide.

ACTION OF BARIUM SALTS.

By its local action in the alimentary canal barium causes **gastro-enteritis** and some degree of corrosion. It is absorbed to a considerable extent, and the most conspicuous of its systemic effects are on the circulation. Barium chloride causes the cardiac contractions to become slower and more forcible, acting like digitalis. The blood-vessels are **constricted**, and the blood pressure rises. The increased tension caused by it may be due in part to the action on the heart, but is chiefly attributable to a very marked contraction of the muscular walls of the vessels. The plain muscular fibres of the intestine may be excited, and the peristalsis is increased. In these respects it resembles ergot, as well as digitalis. It acts like veratrine when applied locally to voluntary muscles, prolonging the contraction; but this effect is done away with by the application of potassium salts. In warm-blooded animals barium salts, injected intravenously, by stimulating the spinal cord and medulla oblongata, induce violent **tonic** and **clonic spasms.** By sufficient quantities the central nervous system is finally paralyzed. Barium is excreted in the urine and probably in the fæces. When given in very dilute solutions the amount absorbed is small, and it is then deposited in the bones. Since barium salts occur very frequently as impurities in many chemical substances, it is well that their physiological actions be kept in mind.

THERAPEUTICS OF BARIUM SALTS.

These salts are not often given to man, but the chloride has been used for **mitral insufficiency** accompanied by irregularity of the heart, for **hæmorrhage**, and as a stimulant in **atony** of the **bladder** or **intestine.** Formerly it was given in nervous diseases. The waters of Llangammarch wells contain .40 gm. (6.7 gr.) to 4545 c.c. (Imperial gallon) of barium chloride, and have been used in cardiac cases. The sulphide has been used as a depilatory.

TOXICOLOGY.

Symptoms.—Poisonous doses cause salivation, thirst, vomiting, purging, difficulty of breathing, a slow pulse, and, from the action on the spinal cord, paralysis of the limbs. The heart is arrested in systole.

Treatment.—Poisoning should be treated by non-irritant emetics and draughts of weak solution of sodium or magnesium sulphate, followed by albuminous drinks, and diffusible stimulants.

3. Emollients and Demulcents.

KAOLIN.

KAOLINUM.—Kaolin.

Preparation.

Cataplasma Kaolini.—Cataplasm of Kaolin. (Kaolin Poultice.)

ACTION OF KAOLIN.

Kaolin is emollient and a drying agent; it has the power in a pronounced degree of clarifying and decolorizing oils, whether animal, vegetable or mineral.

THERAPEUTICS OF KAOLIN.

Kaolin is an efficient dusting powder for inflamed surfaces and irritated conditions of the skin. As it is resistant to most chemical agents, it is used as a basis for making pills of such substances as phosphorus, silver nitrate, and potassium permanganate, in which chemical reaction would ordinarily take place. The Cataplasma Kaolini is an excellent substitute for all poultices of domestic manufacture. Kaolin is employed to quite a large extent in clarifying oils, such as lard and cottonseed oils, as well as wine, beer, honey, syrups, etc.

STEARIC ACID.

ACIDUM STEARICUM.—Stearic Acid.

Preparations.

Zinci Stearas.—Zinc Stearate.

Unguentum Zinci Stearatis.—Ointment of Zinc Stearate.

ACTION OF STEARIC ACID.

Stearic acid has no known general action upon man.

THERAPEUTICS OF STEARIC ACID.

Stearic acid is used in the manufacture of glycerin suppositories. Stearates of zinc and copper (the latter unofficial) have been introduced and used with success in the treatment of various diseases of the skin and mucous membranes.

WOOL-FAT.

ADEPS LANÆ.—Wool-Fat.

Preparation.

Adeps Lanæ Hydrosus. — Hydrous Wool-Fat. (Lanolin. Œsypum.)

ACTION OF HYDROUS WOOL-FAT.

Hydrous wool-fat is very soothing to the skin, and when gently rubbed in is more quickly absorbed than most fats.

THERAPEUTICS OF HYDROUS WOOL-FAT.

As it assists the glandular functions of the skin, it is useful in comedo and anidrosis. In ichthyosis and scleroderma and in senile atrophy of the integument it softens the surface, and inunction with it is considered one of the best methods of obliterating wrinkles. It is serviceable as an application for chapped hands and lips, burns, scalds, frost-bite, erythema, impetigo contagiosa, dermatitis, erysipelas and acute eczema, and, when it contains a sufficient amount of water, is efficient in allaying the itching of scarlet fever and other exanthematous diseases. In chronic eczema with infiltration and in psoriasis it softens the skin and favors the action of remedies which may be combined with it. It is often an excellent basis for ointments expected to act especially upon the skin, but as it passes readily through the integument, it is not well adapted for a protective. It is a useful vehicle for remedies to be used by inunction, and on account of its penetrative power, as well as its ready miscibility with mercury, it is of peculiar value in the inunction treatment of syphilis. It is employed to a considerable extent also as a vehicle for cocaine in affections of the nose and genito-urinary tract, and for cocaine, morphine, atropine and other anodynes in neuralgias and painful joints. It is not used internally.

LARD.

1. **ADEPS.**—Lard.

Preparations.

   1. **Adeps Benzoinatus.**—Benzoinated Lard.
   2. **Ceratum.**—Cerate.
   3. **Ceratum Resinæ.**—Rosin Cerate.
   4. **Ceratum Resinæ Compositum.**—Compound Rosin Cerate.
   5. **Unguentum.**—Ointment.

2. **OLEUM ADIPIS.**—Lard Oil.

ACTION OF LARD.

Lard is one of the best emollients, its application to the skin being followed by a pleasant feeling of softness and flexibility. Melting at the temperature of the body, it is readily absorbed by the integument. The benzoinated lard has the advantage of not quickly becoming rancid, but it is irritating to tender skins.

THERAPEUTICS OF LARD.

When the secretory formation of the skin is impaired or suppressed, inunction with lard serves as a partial substitute for the natural secretion, and such inunction is sometimes employed by professional rubbers as an aid to friction. It is also of service in chest affections. Washed lard, beaten up with an equal quantity of lime water, and a few drops of oil of bitter almond, thymol, or phenol added, is said to make an elegant substitute for Carron oil as a dressing for burns, as well as for some acute inflammations of the skin. On account of its penetrating power, active agents, such as mercury and the alkaloids, can be combined with lard for administration by inunction, and its chief use in medicine is as a basis for ointments.

SPERMACETI.

CETACEUM.—Spermaceti.

Preparation.

Unguentum Aquæ Rosæ.—Ointment of Rose Water.

ACTION OF SPERMACETI.

Spermaceti is emollient and demulcent.

THERAPEUTICS OF SPERMACETI.

It is used almost entirely as a basis for ointments and cerates. In the form of powder, which may be obtained by triturating it with a little alcohol, spermaceti is sometimes employed, mixed with an equal weight of talc, as a dusting powder for the feet, for the purpose of preventing friction.

PETROLATUM.

PETROLATUM.—Petrolatum.

PETROLATUM ALBUM.—White Petrolatum.

PETROLATUM LIQUIDUM.—Liquid Petrolatum.

ACTION OF PETROLATUM.

Petrolatum is purely emollient; it has no nutritive effect.

THERAPEUTICS OF PETROLATUM.

Petrolatum is used principally as a bland, neutral protective, and, because it does not become rancid nor act as an irritant, and as it is not affected by acids, alkalies or powerful reducing agents, it is employed as a substitute for fatty materials in ointments. But as it is absorbed with difficulty it is not a suitable vehicle for drugs which are intended for absorption through the skin. Liquid petrolatum has been used as a local soothing application in inflammation of the mucous membrane of the nose, throat, larynx, and even of the bronchial tubes, by means of an atomizer. It may also be employed as a vehicle for various medicinal substances.

COTTON.

1. **GOSSYPIUM PURIFICATUM.**—Purified Cotton. (Absorbent Cotton.)

2. **PYROXYLINUM.**—Pyroxylin. (Gun Cotton.)

Preparations.

1. **Collodium.**—Collodion.
2. **Collodium Flexile.**—Flexible Collodion.
3. **Collodium Cantharidatum.**—Cantharidal Collodion. (Blistering Collodion.)
4. **Collodium Stypticum.**—Styptic Collodion.

3. **OLEUM GOSSYPII SEMINIS.**—Cotton Seed Oil. **Dose, 16 c.c. (4 fl. dr.).**

ACTION OF COTTON.

None.

THERAPEUTICS OF COTTON.

Cotton is used in various forms as a covering, protection, or support, and also for the topical application of remedies. Absorbent cotton, lint and gauze are frequently medicated, *e. g.*, sal alembroth, 2 per cent.; boric acid, 5 or 10 per cent.; salicylic acid, 5 per cent.; chrysarobin, 10 per cent.; phenol, 5 per cent.; iodoform, 5, 10 and 50 per cent. The only use of pyroxylin is for making collodion, which, when painted on the skin, quickly forms a thin and dry protective film over it, in consequence of the evaporation of the ether. Flexible collodion has the advantage over ordinary collodion of not cracking when thus dried on the integument. These preparations are protective to small wounds and excoriated surfaces, and are used after slight operations. The edges of larger wounds may be drawn together and kept in position by strips of gauze, which are made to adhere to the skin by the application of several coats of flexible collodion. Collodion is especially serviceable for scalp-wounds, in which it often renders a bandage unnecessary. The contraction and compression resulting from the drying of the substance are sometimes utilized in the abortive treatment of boils, and of the papules of small-pox (to prevent pitting), as well as in the treatment of epididymitis (in which the testicle and cord are freely painted over with it), of umbilical hernia, of varicocele, and of spina bifida. Collodion may also be applied in superficial burns, in erysipelas, and in herpes zoster, and, after the parts have been antiseptically cleansed with a phenol solution, it often affords relief in pruritus ani. The closing of the orifice of the urethra or the prepuce with it at bedtime is sometimes successful in putting a stop to nocturnal incontinence of urine in male children. Several cases of tuberculous peritonitis have been reported by French physicians in which the repeated application of collodion to the entire surface of the abdomen was followed by recovery.

ACTION OF COTTON SEED OIL.

Cotton seed oil is nutrient and emollient.

THERAPEUTICS OF COTTON SEED OIL.

This is used simply as a bland, nutritious oil, and in liniments.

OIL OF THEOBROMA.

OLEUM THEOBROMATIS.—Oil of Theobroma. (Cacao Butter.)

ACTION OF OIL OF THEOBROMA.

Oil of theobroma is nutrient and emollient.

THERAPEUTICS OF OIL OF THEOBROMA.

Oil of therobroma is used to make suppositories. It is also used by inunction to improve the nutrition of the body. Its slight tendency to become oxidized renders it serviceable for preserving steel instruments from corrosion by exposure to the air.

FLAXSEED.

LINUM.—Linseed. Flaxseed.

OLEUM LINI.—Linseed Oil. (Flaxseed Oil.) **Dose, 30 c.c. (1 fl. oz.).**

Preparation.

Linimentum Calcis.—Lime Liniment.

ACTION OF FLAXSEED.

Flaxseed is demulcent and emollient. It has been thought by some to have expectorant qualities, but it probably has no direct action on the bronchial mucous membrane. It is mildly diuretic, and its preparations, if given in sufficient amount, have a laxative effect. Its diuretic action, it is believed, may be due to the excretion by the kidneys of the resinoid oxidation products formed from the oil.

THERAPEUTICS OF FLAXSEED.

Externally the meal (lini farina), in the form of poultices (4 to 10 of boiling water with constant stirring and the basin being kept hot), is used for the purpose of applying warmth and moisture, especially in inflammatory conditions, both superficial and deep-seated. It relaxes the tissues and relieves pain. It tends to check inflammation if applied early, and accelerates the evacuation of pus after suppuration has commenced. The poultice, as ordinarily used, however, is uncleanly, and has come to be regarded as a hot-bed for bacteria and not infrequently a means of favoring the extension of the infectious process present. It has been suggested as a good method of preparing poultices to make several bags of suitable size, of either of the fabrics known as Swiss and cheese cloth, fill them half-full with flaxseed meal, and then sew up the open ends. When wanted for use, one of these bags is submerged in boiling water for a few minutes (which causes the meal to swell so as to fill the bag), and, after the superfluous water has been squeezed out, it is laid on the affected part and covered with oiled silk and a bandage. Care should, of course be taken not to apply the poultice so hot as to scald the skin. Flaxseed and other poultices not only promote local vascular dilatation, but also have a counter-irritant effect. Their action may be increased, if desired, by the addition of 1 part of mustard to 16 of the material composing the poultice, or by smearing the surface to be covered with equal parts of belladonna and glycerin, or sprinkling on it a little dry mustard or a few drops of turpentine. Laudanum, or lead-water and laudanum, may be incorporated in the poultice or applied under it if there is much pain or if the skin is broken. Poultices are also sometimes medicated with astringents and other agents. Linseed oil, made into an emulsion with an equal part of lime-water which is popularly known as Carron oil (the official *Linimentum Calcis*), was long a favorite remedy for burns, but as it is uncleanly and has a disagreeable odor, it has largely been supplanted by other agents. The oil is also sometimes used for laxative purposes as an enema, especially in children. An infusion of flaxseed, 1 to 32, is considered an excellent enema in inflammation of the rectum, fissure, piles, etc., and is also used as an injection in irritations of the bladder and vagina. Flaxseed mucilage, prepared by boiling the seed, has been employed to a considerable extent as an external application in erysipelatous and other cutaneous inflammations, burns, etc., but if allowed to get dry it renders the skin stiff. Flaxseed tea (flaxseed, 3; licorice, 1; boiling water, 100; infuse for two hours) is a common domestic demulcent, which is used especially in acute bronchitis and sore throat. If given hot it has a diaphoretic effect, and the large amount of mucilage which it contains renders it very soothing to the inflamed mucous membrane. In the mouth and pharynx it forms a coating which is of service in relieving "tickling of the throat" and irritative cough. The hot infusion is also used to a considerable extent in enteritis and dysentery and in irritation of the stomach and the kidneys, cystitis, strangury, etc. It should never be boiled during the process of preparing it, as the application of too much heat causes the extraction of more or less of the oil, and so renders it less palatable. Lemon and sugar may be added, according to the taste of the patient, and it may be taken *ad libitum*. Whole flaxseed, in doses of 15 gm. (½ oz.), is occasionally used as a laxative in habitual constipation, and the oil in doses of 60 c.c. (2 fl. oz.) has been recommended as a laxative in the treatment of hæmorrhoids.

OLEUM OLIVÆ.—Olive Oil. (Sweet Oil.) **Dose, 30 c.c. (1 fl. oz.).**

OLIVE OIL.

ACTION OF OLIVE OIL.

Olive oil is lubricant, emollient, demulcent, nutritive and mildly laxative. Externally applied it acts as a protective to the skin, which it renders soft and pliant. When rubbed in with sufficient friction it is absorbed, and afterwards assimilated by the system. Taken by the mouth, it is, like other oils, partly emulsified and partly saponified in the intestine, and the olein it contains is finally deposited in the body as fat. If the quantity ingested is larger than can be absorbed, the excess will appear unchanged in the urine.

THERAPEUTICS OF OLIVE OIL.

External.—It is much used to facilitate the rubbing of joints and other parts of the body. It is sometimes employed in massage, but lanolin is considered better for this purpose. Unless the skin is very harsh, dry or scaly, however, the manipulation can usually be more efficiently performed without any lubricant. Warm olive oil is useful for removing crusts in such conditions as seborrhœa, eczema and psoriasis. It should not be allowed to get into the eyes, as it is liable to produce considerable irritation if it comes in contact with the conjunctiva. It is a common soothing protective in burns and acute inflammatory affections of the skin, coating the surface and excluding the air. In the former it is sometimes used in place of linseed oil in Linimentum Calcis (*see* p. 196). Olive oil is employed as an emollient addition to poultices, and with poultices applied in the ordinary way it is of service in preventing them from adhering; for this purpose it may either be incorporated in the poultice or smeared on the surface to which the latter is to be applied. As it is absorbed by the lymphatics when rubbed vigorously into the skin, it may be used in this way for the purposes of a food in cases where sufficient nourishment cannot be taken by the mouth. As a nutritive, however, it is less valuable than cod liver oil, which is administered to a considerable extent by inunction in wasting diseases. Oil inunctions are of great service in scarlet fever and other exanthematous diseases. They reduce temperature and are very grateful to the patient; allaying the burning heat and itching of the skin, and in this way diminishing excitement and restlessness. Their antipyretic effect is also probably due to a considerable extent to their influence in mitigating one of the chief sources of distress in this class of affections. They are especially valuable in the desquamative stage of scarlet fever, where they serve a prophylactic purpose by preventing the dispersion of the scales in the atmosphere. By dropping a little olive oil into the auditory canal insects can readily be removed from the ear. The oil was formerly much used as a lubricant for catheters, sounds and other instruments, but vaseline has here replaced it to a considerable extent. It is employed as an ingredient in many liniments, plasters, ointments and cerates, but the foreign article is so frequently adulterated with inferior oils that cotton-seed oil is now directed in its place in many official preparations. A very large proportion of the olive oil of commerce at the present day is known to be in reality cotton-seed oil, and there appears, indeed, to be no appreciable difference between the physiological and therapeutic properties of the two, although cotton-seed oil is not so agreeable in flavor. Olive oil is a common application in the bites and stings of insects, and in some parts of Europe and the east it is used both locally and internally in the treatment of snake bites.

Internal.—From ancient times to the present it has been an article of diet in olive-growing lands, but, except as an ingredient of salad-dressings, it is not much used as a food in this country. Taken promptly into the stomach in sufficient quantity, it is useful in mitigating the effects of irritating poisons, but it should not be employed after phosphorus has been swallowed, as the latter dissolves in it. As a laxative it is much used (in teaspoonful doses) for infants, and it also answers very well sometimes in adults. Where the patient does not object to its taste it may be advantageously given with food. It is especially recommended in the constipation caused by opium and as a demulcent laxative in hæmorrhoids and fissure of the anus. Occasionally it has been successful, when given in large doses, in causing the expulsion of tape-worms. On account of its blandness it is frequently prescribed in the form of an enema, which may be composed entirely of olive oil or of oil and warm mucilage of starch in the proportion of 15 to 18. The soap enema (soap, 1; warm water, 32), however, is the one most generally employed for ordinary purposes. Olive oil is sometimes injected into the rectum to get rid of thread-worms, but is not as reliable as some other agents. It has been found very useful in the case of workmen employed in white-lead factories in keeping the bowels free and preventing the absorption of the metal, and it is also efficient in the treatment of lead colic itself. There is now at command some clinical evidence of the marked value of olive oil in biliary calculi. While outside the body the oil is a solvent for cholesterin, the chief constituent of gall-stones, it has been doubted by some if when taken internally, even in very large amount, it is possible for the oil to exert this solvent action. High authorities claim that it does assist materially in the solution of calculi; but whether this is the case or not, there can be no question that it is of service in cholelithiasis by increasing the watery secretion of bile. It is recommended that not less than from 60 to 250 c.c. (2 to 8 fl. oz.) should be taken daily. It may be rendered more palatable by the addition of a small quantity of menthol and 4 c.c. (1 fl. dr.) of brandy to each 250 c.c. (half-pint), or it may be given in aromatized emulsion with a little brandy or whiskey. Certain patients can take it better mixed with fish, mashed potatoes, or other kinds of food. Some assert that the best results may be obtained by giving from 30 to 60 c.c. (1 to 2 fl. oz.) of olive oil in hot milk for ten nights in succession. The remedy is then omitted for a week, and this course is kept up for a number of months. In addition to the treatment of the gall-stones themselves, sodium benzoate and salicylate are recommended as intestinal antiseptics. Olive oil, in doses increasing from 15 to 90 c.c. (½ to 3 fl. oz.), is said to have caused the disappearance of obstructive jaundice. In obstinate and painful cases of dry pleürisy a small quantity of the oil, sterilized, has been injected into the pleural sac with the idea of imitating Nature in providing a lubricating fluid.

OLEIC ACID.

ACIDUM OLEICUM.—Oleic Acid.

ACTION OF OLEIC ACID.

Oleic acid is bland and unirritating, and penetrates the skin more readily than fats and oils.

THERAPEUTICS OF OLEIC ACID.

It is not employed by itself in medicine, but used pharmaceutically in the preparation of oleates and also in plasters and soaps. Oleates, which are readily soluble, and thereby rendered more efficient for local application, are made from the alkaloids, not from their salts. If metals are employed, the oxides only are chosen. The oleates are used for the purpose of securing the absorption of drugs through the skin. Many substances which are either not absorbed at all or only to a very limited extent from aqueous solutions, are freely absorbed from oily ones, while many which are not soluble in oils dissolve in oleic acid. Hence the special utility of the oleates. Besides the official oleates, a considerable number of others are also now in use. Some of them, such as the oleate of copper, are excellent parasiticides, and this class of preparations is steadily growing in favor in the treatment of cutaneous affections generally, as well as of a variety of other conditions.

SOAP.

1. **SAPO.**—Soap. (White Castile Soap. Hard Soap.)

Preparations.

1. **Emplastrum Saponis.**—Soap Plaster.
2. **Linimentum Saponis.**—Soap Liniment. (Opodeldoc.)

2. **SAPO MOLLIS.**—Soft Soap. (Green Soap.)

Preparation.

Linimentum Saponis Mollis.—Liniment of Soft Soap. (Tincture of Green Soap.)

ACTION OF SOAP.

Externally soap is detergent and discutient, combining with the fat of the excretions and removing, along with this, epithelial scales, bacteria and dirt, or other foreign matter. Internally it is laxative and antacid. While it softens the epidermis, it may set up considerable irritation if applied too long or with too much friction, or if the soap used is too strongly alkaline or not sufficiently diluted with water.

THERAPEUTICS OF SOAP.

In modern surgery it is customary to scrub the part to be operated upon with hard soap and water before washing it with an antiseptic solution. Good Castile soap is considered the best representative of a pure soap to be had. Hard soap, in powder, is used to some extent as an ingredient of dentifrices, and it no doubt aids in the preservation of the teeth. In recent years it has been considerably employed for medicated soaps, which, if judiciously applied, are decidedly beneficial in a variety of cutaneous affections. Among the agents commonly incorporated in them are sulphur, tar, phenol, mercury bichloride, ichthyol, eucalyptol, naphthol and salicylic acid. In ordering a medicated soap the desired percentage of the drug to be used should be given in the prescription. As to soaps ordinarily used for cleansing, most toilet soaps, it has been pointed out, are too strongly alkaline and often contain irritating essential oils; while many cheap kinds are made with animal fat which has not been properly purified, and therefore liable to contain the bacteria of putrefaction and possibly of disease. In the case of persons with delicate skins, and especially infants, it is very important that only a bland and pure article should be selected. A carefully prepared glycerin soap is believed to be, on the whole, the best for the skin. Soap suppositories inserted in the rectum generally cause a prompt evacuation of the bowels, and are frequently resorted to in the constipation of infants. For use in adults, particularly, their efficiency may be increased by the addition of glycerin. Hard soap is a good excipient for pills, and it forms the basis of several of those in the Pharmacopœia. Soap is of considerable value as an antidote in poisoning by acids and other irritants. It also acts as an aid to emetics, and has the great advantage of being always accessible. In such cases its use should be resorted to at the earliest possible moment and continued until more powerful alkalies, such as chalk, magnesia, or sodium bicarbonate, can be obtained. A teacupful of solution of soap, in the proportion of about one to four, by weight, of water, may be repeated at short intervals until the patient has taken all that he can swallow. If promptly applied, soapsuds are also an excellent remedy for external burns by acids and by phosphorus. Soap was formerly used to some extent in dyspepsia attended with inactivity of the liver and constipation, and is still occasionally employed in acidity of the stomach, as it is readily decomposed by very weak acids, which combine with the alkali. Even as an antacid, however, it has been largely supplanted by other agents, and it is very rarely given internally at all except in combination with other agents in pills. Soap plaster is protective against bed-sores, and is also sometimes used as a support about sprained joints. Linimentum Saponis is a cutaneous stimulant. It is employed with friction in sprains, stiffness of the joints or muscles, etc., and it constitutes the basis of the official chloroform liniment. It is also a favorite basis for extemporaneous liniment prescriptions, and such agents as aconite, opium and belladonna are frequently combined with it.

Soft soap, which is also known as green soap, although it is not generally green, but of a brownish color, is much more strongly alkaline than hard, and, containing free potassium hydroxide, as it does, is decidedly irritant. It has a softening effect on tissues with which it comes in contact, and is therefore of considerable service in chronic indurations of the skin. One of its uses is to remove crusts and epithelial scales in cutaneous affections. It is also of value in the general treatment of a number of diseases of the skin, and among the more prominent of those in which it has proved of service are chronic psoriasis, acne, tinea, and even lupus. If there is much itching, it may be combined with oil of cade. For chronic eczema it has been found that the best form in which to use it is the Linimentum Saponis Mollis, which should be well rubbed into the affected part and followed by a soothing application, such as simple cerate. The liniment is an excellent cleansing agent for the scalp, especially in seborrhœa, and for shampooing purposes it should be diluted with three parts of alcohol or Cologne water. When pediculi are present it is useful in preparing the way for a parasiticide application by dissolving the adhesion of the nits to the hair shafts. This, like the Linimentum Saponis, is also employed as an application, usually enforced by more energetic medicinal agents, for sprains, stiff joints, etc. Soft soap is furthermore used locally in the treatment of enlarged glands, whether the condition is a simple inflammatory one or of strumous or syphilitic origin. Its external application may be of some service, as well, in other strumous or tuberculous conditions, such as disease of the mesenteric glands or periostitis, and in exudations into serous cavities. One of the most common uses of both hard and soft soap is for purgative enemata; but the latter is decidedly preferable. For this purpose either may be made into a lather with 500 c.c. (1 pint) or more of water at a temperature of 37.8° C. (100° F.). Soap enemata are somewhat liable to give rise to an erythematous or urticarial eruption, and this appears to be especially the case with those made with hard soap. In some individuals such a rash makes its appearance regularly after each injection, however often the enema may be repeated. This may be due to some irritant in the soap employed, or possibly, as some are inclined to believe, may result from the solution and consequent absorption of some fæcal toxin. Doubt has been expressed whether the rectal injection of soap and water has any more effect in causing an evacuation of the bowels than would an enema of warm water alone or the same quantity of thin oatmeal gruel; but it seems altogether probable that the soap itself has some purgative action, though this may sometimes be but slight. In order to increase the efficiency of a soap enema it may be advisable to add to it a certain amount of castor oil. The quantity of soft soap used is usually about 30 c.c. (1 fl. oz.). In some hospitals there is employed an enema, known as the "House Mixture," which consists of soft soap, molasses and water in varying proportions, and to which turpentine and olive oil are added if flatulence be present. This, it is claimed, is "as efficient as it is cheap and dirty."

MALT.

MALTUM.—Malt. (Byne.)

Preparation.

Extractum Malti.—Extract of Malt. **Dose, 16 c.c. (4 fl. dr.).**

Unofficial Preparation.

Taka-diastasum.—Taka-diastase. **Dose, 0.30 to 0.60 gm.; 5 to 10 gr.**

ACTION OF MALT.

Malt is demulcent and nutritive. Many of the malt extracts manufactured are quite inert as regards the digestion of starch, inasmuch as the diastase of the malt has been destroyed by the heat employed in their preparation; but, while thus devoid of digestive power, they form a pleasant, easily digested food. Alcohol, as well as heat, destroys the ferment, and the liquid malts containing alcohol are also worthless for assisting starch digestion. Many are only beers of an inferior quality, and the best of them are indistinguishable from stout. True extract of malt contains no alcohol at all. Taka-diastase, which is named after its discoverer, Takamine, and is an enzyme derived from *Eurotium oryzæ*, a fungus of the aspergillus family, has been found to be very much more energetic than any of the malt extracts, as it digests over one hundred times its own weight of starch. As soon as the acidity of the gastric juice exceeds 0.1 per cent. it ceases to act in it, but it is able, no doubt, to digest a considerable amount of starch in the mouth and stomach before it is destroyed. It is a question of great practical interest, however, whether the ordinary digestive juices are ever unable to digest the starch of the food, and it has been stated that no satisfactory evidence of the existence of a supposed class of cases to which the name of amylaceous dyspepsia has been given has been brought forward. Until it is shown that in some instances the digestion of starch by the intestinal ferments is insufficiently performed, the diastaste preparations would seem, therefore, to be superfluous. As the opinion is very widely held, however, that in many cases the natural ferments do fail to adequately perform this function, and that in them diastase to some extent supplies their place, it appears to be the part of wisdom, for the present at least, to give the latter the benefit of the doubt. All malts, consequently, should be rejected which do not contain at least 4 per cent. of diastase. Maltose, which is a product of the action of the ferment diastase upon starch, leads to the formation of fat and constitutes, in many conditions, a very excellent food. Its value in this respect rests on the fact that it is readily absorbed both in the stomach and small intestine. In the system it undergoes a transformation into dextrose, and it is not found present as maltose in the tissues. As the malt liquors contain malt extract, as well as hops, an aromatic bitter, their nutritive, tonic and stomachic qualities are greater than those of spirits and wine. At the same time, it must not be forgotten that the beneficial effects of these constituents are to a very considerable extent diminished by the process of fermentation; so that the value of such beverages as foods is apt to be greatly exaggerated by their habitual consumers. They increase the appetite and lead to the deposition of fat, and when taken in excess are not infrequently the cause of fatty degeneration in various organs, more particularly the liver and the heart.

THERAPEUTICS OF MALT.

Malt extracts, the value of which depends principally on the amount of maltose they contain, are used in all conditions where it is desirable to give a readily assimilable carbohydrate food. They are particularly indicated in convalescence from acute disorders, in the derangements of the system caused by chronic disease, and in cases of wasting and of poor digestion and assimilation. They are usually well borne by the stomach, and in many instances can be taken by those who reject other nutritive agents, such as cod liver oil. While not possessing all the virtues of the latter in pulmonary tuberculosis, they sometimes prove a satisfactory substitute for it. Not infrequently extract of malt is advantageously combined, in emulsion, with cod liver oil; the comparatively small dose of the latter then required being less apt to disagree with the patient than a larger quantity taken by itself. Such emulsions should contain about 1 part of oil to 4 of malt. Malt extracts are very largely given for the purpose of assisting the digestion of starchy foods. Diastase, it should be remembered, like the ferments of the saliva and pancreatic fluid, can act only in a neutral or alkaline medium. Usually, it is directed to be taken at least two hours after a meal, by which time the stomach is presumed to be free from the acid gastric juice. By some authorities it is believed that in most cases the administration of diastatic ferments is of little benefit, and that the great value attached to them rests on the fact that they are useful agents in producing predigested foods. Malt extract may be used to form a syrupy mixture with preparations of iron or cinchona. The following will often be found serviceable: Ferric pyrophosphate, 2; water, 3; dissolve and add extract of malt, 95. Dose, 4 to 15 c.c. (1 to 4 fl. dr.). Malt extract, to which a suitable amount of fluidextract of cascara sagrada has been added, is an excellent laxative.

SUGAR.

SACCHARUM.—Sugar. (Cane Sugar. Sucrose.)

Preparation.

Syrupus.—Syrup.

Unofficial Preparation.

Levulosum.—Levulose. (Fruit Sugar. Diabetin.)

ACTION OF SUGAR.

Sugar is nutrient, demulcent and **antiseptic.** It is an antiputrefactive, but not an antifermentative. While essentially a food, it contains no nitrogen, and is therefore incapable of sustaining life by itself; in the system, however, it develops adipose tissue and acts as a respiratory fuel. In the healthy individual sugar and sugar-forming food, it is estimated, constitute more than one-half of the nourishment required by the body. It also has some diuretic action. Eaten freely, it is said to interfere with the development of alcoholic intoxication, an effect which has been attributed to its retarding gastric absorption.

THERAPEUTICS OF SUGAR.

Sugar is used as a sweetening and preservative agent. Syrup is used as a vehicle. Syrupus Glucosi (not official): syrup, 2, liquid glucose of commerce, 1, is used in pharmacy, especially in the making of pills, as it forms a neutral basis. Sugar is the principal basis of troches, gum pastilles, and various other preparations. Mixed with iron preparations, it is a protective against oxidation. On account of its attraction for water, powdered or granulated sugar, locally applied, makes a good styptic (which is also antiseptic), in cases of emergency. White sugar does not seem to have any aperient effect, but molasses and imperfectly refined sugar intensify intestinal action and are considerably used in domestic medicine as mild laxatives. When taken in moderation sugar tends to promote digestion and allay nervous excitement, and sweetened water (*eau sucrée*) is very extensively used for such purposes in France and other parts of Europe. In catarrhal affections of the air-passages sugar has a soothing effect upon the mucous membrane, and the vapor of boiling cane-juice is stated to have proved of great value in bronchitis and even pulmonary tuberculosis. Finely powdered lump sugar may relieve the hiccough of nursing infants which arises from over-feeding, and lump sugar is a common domestic remedy for hiccough in general. The chemical compound which sugar forms with lime, calcium saccharate (Syrupus Calcis), is said to be an antidote to phenol. Sugar is contra-indicated in diabetes mellitus, obesity, and conditions involving fermentative changes in the stomach or intestines. Levulose, a fruit-sugar sold under the name of *Diabetin,* is now extensively used as a food and substitute for cane-sugar in cases of diabetes. It is well assimilated in the disease, a small proportion only being excreted in the urine, and is regarded as having the same nutrient value as cane-sugar.

LICORICE.

GLYCYRRHIZA.—Glycyrrhiza. Licorice Root. **Dose, 2 gm.; 30 gr.**

Preparations.

1. **Elixir Adjuvans.**—Adjuvant Elixir.
2. **Extractum Glycyrrhizæ.**—Extract of Glycyrrhiza. (Extract of Licorice.) **Dose, 1 gm. (15 gr.).**
3. **Extractum Glycyrrhizæ Purum.**—Pure Extract of Glycyrrhiza. **Dose, 1 gm. (15 gr.).**
4. **Fluidextractum Glycyrrhizæ.**—Fluidextract of Glycyrrhiza. **Dose, 2 c.c. (30 ♏).**
5. **Glycyrrhizinum Ammoniatum.**—Ammoniated Glycyrrhizin. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
6. **Mistura Glycyrrhizæ Composita.**—Compound Mixture of Glycyrrhiza. (Brown Mixture.) **Dose, 8 c.c. (2 fl. dr.).**
7. **Pilulæ Laxativæ Compositæ.**—Compound Laxative Pills. **Dose, 2 pills.**
8. **Pulvis Glycyrrhizæ Compositus.**—Compound Powder of Glycyrrhiza. **Dose, 4 gm. (60 gr.).**
9. **Trochisci Glycyrrhizæ et Opii.**—Troches of Glycyrrhiza and Opium.

ACTION OF LICORICE.

Licorice is demulcent, expectorant and laxative. Locally it has a slightly stimulating action, and it increases the flow of saliva and mucus when slowly chewed or sucked.

THERAPEUTICS OF LICORICE.

In sore throat and bronchitis licorice is an excellent demulcent. The pure extract is a popular remedy for tickling cough and hoarseness, and Brown Mixture is much used in dispensary practice as an expectorant. Licorice is largely employed to conceal the taste of disagreeable medicines and as a basis for pills. The root is commonly used as a dusting-powder and coating for the latter. The compound licorice powder is a pleasant and efficient laxative, and is especially well adapted for children and pregnant women. When necessary, it may be advantageously combined with an equal quantity of compound jalap powder. The demulcent properties of licorice render it serviceable in irritable conditions of the mucous membrane of the bladder and intestines, as well as of the air-passages. It may also be given with flaxseed tea or barley water in various febrile affections. Ammoniated glycyrrhizin possesses no advantage over the extract, and is devoid of the demulcent properties of the drug.

SLIPPERY ELM BARK.

ULMUS.—Elm. (Slippery Elm Bark.)

Preparation.

Mucilago Ulmi.—Mucilage of Elm. **Dose, 16 c.c. (4 fl. dr.).**

ACTION OF SLIPPERY ELM BARK.

Slippery elm bark is demulcent and in some degree tonic and nutritive, as well as slightly astringent.

THERAPEUTICS OF SLIPPERY ELM BARK.

Slippery elm bark is especially recommended in dysentery, diarrhœa and diseases of the urinary passages. It is often employed to make poultices, especially for use upon children, because it is lighter than flaxseed. The poultices, with lead water, are serviceable in erysipelas and various forms of local inflammation; they may be applied either hot or cold. The bark is also used in the dilatation of fistulæ, strictures and the os uteri, and, in conjunction with various medicinal extracts, in the formation of rectal and vaginal suppositories. When chewed it moistens the mouth and throat, and employed in this way it is soothing in irritable conditions of the faucial and bronchial mucous membrane. It is stated to have sometimes proved successful in the treatment of tapeworm.

ACACIA.

ACACIA.—Acacia. (Gum Arabic.)

Preparations.

1. **Mucilago Acaciæ.**—Mucilage of Acacia. **Dose, 16 c.c. (4 fl. dr.).**
2. **Syrupus Acaciæ.**—Syrup of Acacia.

ACTION OF ACACIA.

Acacia is a valuable demulcent. It has been experimented with as a food, but appears to have little or no nutrient quality, though it may possibly retard tissue-waste and in this way prove capable of prolonging life.

THERAPEUTICS OF ACACIA.

On account of its demulcent properties it is employed at times in inflammatory conditions of the bronchial, gastric, vesical and intestinal mucous membrane, in which it acts as a local palliative. One part dissolved in 30 of water and flavored with syrup of lemon, or otherwise, makes a pleasant and serviceable beverage. Acacia is also useful as a vehicle for more powerful remedies. As a protective to the inflamed surfaces in pharyngitis, laryngitis, etc., it is commonly used in the form of lozenges, in which astringents or other agents may be incorporated in accordance with the indications present. To loosen hacking coughs it is largely employed with flaxseed in the form of a mucilage, flavored with lemon-juice and sweetened, to which liquorice is generally added. Mucilage of acacia may sometimes be of service in cases of irritant poisoning. One of the chief uses of acacia is to emulsify oils and resins. 30 c.c. (1 fl. oz.) of most oils or resinous tinctures require 12 c.c. (3 fl. dr.) of mucilage of acacia for suspension, but copaiba requires 40 c.c. (10 fl. dr.). The tendency of the mucilage to undergo acetous fermentation, which greatly interferes with its emulsifying capacity, may be overcome to some extent by making it with tolu or clove water. For the suspension of insoluble powders it is not so satisfactory as tragacanth, as it is liable to form cements which are difficult to disperse. Externally, acacia has a certain amount of utility. Its thick mucilage, to which some antiseptic should be added, may be employed as a protective for superficial burns, excoriations and ulcers. Powdered acacia is sometimes used to arrest bleeding from leech bites and other sources of slight hæmorrhage. Mixed with one-half its quantity of powdered arrow-root and one-quarter of borax, together with a small amount of camphor, it is serviceable, dusted over the surface, for sore nipples. An ointment made with 6 parts of powdered acacia and 1 of oleate of zinc, to 8 of lanolin, is also a good application in this affection, as well as in some diseases of the skin. A snuff composed of acacia and bismuth subnitrate, to which a little morphine may be added, is often useful in checking coryza.

TRAGACANTH.

TRAGACANTHA.—Tragacanth.

Preparation.

Mucilago Tragacanthæ.—Mucilage of Tragacanth. **Dose, 16 c.c. (4 fl. dr.).**

ACTION OF TRAGACANTH.

Tragacanth is demulcent and slightly nutritive. If given in large quantity it is apt to cause indigestion, unless accompanied by some antiseptic agent, like creosote or naphthol, in order to prevent fermentation.

THERAPEUTICS OF TRAGACANTH.

Its chief use is to suspend insoluble powders. The mucilage is better for this purpose than the compound powder (not official): tragacanth, 1; acacia, 1; starch, 1; sugar, 3; which, because of its starch, is liable to ferment. Moreover, acacia is contra-indicated when tragacanth is employed as a suspending agent. Tragacanth is less useful than acacia as an emulsifying agent for resins and oils, for the reason that it is almost insoluble in water. It is sometimes used as a vehicle for medicinal agents in gargles, and is a constituent of most of the official troches. It may be employed as a demulcent in pharyngitis, gastritis and intestinal inflammation. On account of its greater tenacity, mucilage of tragacanth may sometimes be preferable to that of acacia as an external protective.

ALMOND.

1. **AMYGDALA AMARA.**—Bitter Almond.

2. **OLEUM AMYGDALÆ AMARÆ.**—Oil of Bitter Almond. **Dose, 0.03 c.c. (½ ♏).**

Preparations.

1. **Aqua Amygdalæ Amaræ.**—Bitter Almond Water. **Dose, 4 c.c. (1 fl. dr.).**

2. **Spiritus Amygdalæ Amaræ.**—Spirit of Bitter Almond. (Essence of Bitter Almond.) **Dose, 0.5 c.c. (8 ♏).**

3. **Syrupus Amygdalæ.**—Syrup of Almond. **Dose, 4 c.c. (1 fl. dr.).**

3. **BENZALDEHYDUM.**—Benzaldehyde. **Dose, 0.03 c.c. (½ ♏).**

4. **AMYGDALA DULCIS.**—Sweet Almond. (Jordan Almond.)

Preparation.

Emulsum Amygdalæ.—Emulsion of Almond. (Milk of Almond.) **Dose, 120 c.c. (4 fl. oz.).**

5. **OLEUM AMYGDALÆ EXPRESSUM.**—Expressed Oil of Almond. **Dose, 30 c.c. (1 fl. oz.).**

ACTION OF ALMOND.

The sweet almond is demulcent and nutritive. Bitter almond, which differs from it in containing amygdalin, is poisonous in large quantities.

THERAPEUTICS OF ALMOND.

The official emulsion is a soothing and emollient drink which may prove of service in irritations of the pharynx and air-passages, as well as of the stomach and intestines. It is also a pleasant vehicle for other remedies in various conditions, and is especially useful for insoluble drugs. The emulsion of bitter almond (not official), in teaspoonful doses, is used for the same purposes, and particularly as a vehicle for expectorant medicines. Both emulsions are employed to some extent as a vehicle in gonorrhœa, as they serve to relieve ardor urinæ. The compound powder of almonds (sweet almond, 8; sugar, 4; acacia, 1) is a palatable basis for powders. The expressed oil of almond might be used for the same purposes as olive oil, but is more expensive. To most persons it is much more palatable than the latter. This oil is used to a considerable extent in ointments, producing a whiter preparation than olive oil, and is especially useful as an application to the hair. It is serviceable for excoriations, chapped hands, and inflammatory affections of the skin, and also as a local application in earache. Internally it may be used as a laxative. One of the most important medicinal uses of the sweet almond is in the form of bread and biscuits made from almond flour. They contain practically no starch, and, being palatable and nutritious, have proved a very satisfactory substitute for the various preparations of wheat flour in the diet of diabetics. They are expensive, but with a little care may be made at home; thus reducing the cost to the minimum. Almond meal is sometimes used instead of soap for the toilet, rendering the skin soft and smooth. Sweet almond emulsion, combined with bismuth subnitrate and thymol iodide, or with ammonium chloride and mercury bichloride, may be used locally for the removal of sunburn, freckles and skin pigmentations. With mercury bichloride alone it is recommended in acne rosacea. As a substitute for cherry-laurel water, which is considerably used in Europe as a sedative narcotic and which owes its effects to the hydrocyanic acid which it contains, but which is objectionable from its unequal strength, it has been proposed to employ an extemporaneous mixture of amygdalin with emulsion of sweet almond. The benzaldehyde produced synthetically is identical with the natural oil of bitter almond, and is employed for the same purposes.

GLYCERIN.

GLYCERINUM.—Glycerin. Glycerol. **Dose, 4 c.c. (1 fl. dr.).**

Preparations.

1. **Gelatinum Glycerinatum.**—Glycerinated Gelatin.

2. **Glyceritum Acidi Tannici.**—Glycerite of Tannic Acid. **Dose, 2 c.c. (30 ♏).**

3. **Glyceritum Amyli.**—Glycerite of Starch.

4. **Glyceritum Boroglycerini.**—Glycerite of Boroglycerin.

5. **Glyceritum Ferri, Quininæ et Strychninæ Phosphatum.**—Glycerite of the Phosphates of Iron, Quinine and Strychnine. **Dose, 1 c.c. (15 ♏).**

6. **Glyceritum Hydrastis.**—Glycerite of Hydrastis. **Dose, 2 c.c. (30 ♏).**

7. **Glyceritum Phenolis.**—Glycerite of Phenol. (Glycerite of Carbolic Acid.) **Dose, 0.3 c.c. (5 ♏).**

8. **Suppositoria Glycerini.**—Suppositories of Glycerin.

ACTION OF GLYCERIN.

External.—Glycerin is powerfully **hygroscopic.** Applied to the cutaneous surface, it is somewhat **irritant,** and even when diluted causes a temporary smarting in cuts and abrasions. This local irritation is attributable to its great avidity for water, in consequence of which it tends to abstract the fluids from the tissues. The pain quickly subsides, however, and it then acts as a protective to the parts. In its completed action, especially when diluted, it is **emollient** and **demulcent** to the skin and to mucous membranes. When injected into the rectum, however, it causes, by its irritant action, peristalsis and evacuation of the bowels.

Internal.—In animals large doses of glycerin, injected subcutaneously, cause death in periods varying from one hour to several days according to the amount administered. The symptoms noted are restlessness, acceleration of the heart and respiration, dryness of the mucous membrane, with marked thirst, loss of muscular power, vomiting, bloody urine, fall of temperature, convulsions, somnolence, coma, and death from failure of the respiration. The larger the dose, the more pronounced the convulsions, which are tetanic in character. In such cases the fall of temperature is preceded by a considerable rise, while in the more prolonged cases (in which the dose is not excessive) the fall may or may not be preceded by a rise, and does not usually occur until quite late in the poisoning. The principal change found *post mortem* is intense pulmonary, renal and intestinal congestion, with more or less softening of the tissue. Glomerulo-nephritis has sometimes been observed. The hæmoglobin which appears in the urine when glycerin is subcutaneously injected in large quantities is due to the destruction of the red blood-corpuscles; although when glycerin is added to the drawn blood it does not act as powerfully on it as many other agents which produce no hæmoglobinuria. The latter effect after its subcutaneous injection has been explained on the hypothesis that the glycerin remains outside the vessels for some time, and withdraws the fluid from the red corpuscles as they pass through the poisoned zone. When, however, glycerin is injected into the blood, it diffuses rapidly throughout the body, and the blood-cells are less acted on by the diluted poison. Accordingly, it is found that hæmoglobin scarcely ever appears in the urine after intravenous injection, although this is occasionally noted when glycerin is given in large doses by the mouth. The violent convulsions caused by it would seem to indicate that glycerin acts directly on the central nervous system. Notwithstanding the fact that in animals it destroys life in a few hours, in man very large doses of glycerin, taken by the mouth, ordinarily produce only a mild gastro-intestinal irritation. In the case of a man who was accustomed to take 90 c.c. (3 fl. oz.) daily it is said, however, to have caused extreme cerebral excitement. Glycerin is rapidly absorbed from the intestine and undergoes oxidation in the tissues; only a very small fraction of it appearing in the urine. Like alcohol, which is also readily absorbed, it therefore acts in some sense as a food, and serves to increase the total energy of the body. Glycerin, it has been pointed out, tends to increase the non-nitrogenous, and not the nitrogenous reserve of the body, its combustion saving a certain amount of the fat from being destroyed. It is, therefore, of only secondary importance as a food, although, like alcohol, it may be of value in certain conditions. As in the case of the latter, it is still regarded as undecided how far it leads to an economy of the nitrogenous tissues, as the fats and carbohydrates do. Internally, as well as externally, glycerin is a good demulcent, but, since it is so quickly absorbed, its action does not extend beyond the stomach. It has been claimed by some authors that its administration at times occasions the appearance in the urine of a substance which reduces cupric oxide and gives the fermentation test for sugar, but this is stated not to have been confirmed on more careful investigation. In some forms of experimental glycosuria glycerin appears to reduce the amount of sugar present, and it is believed that it probably has some effect on the sugar formation in the tissues, although no satisfactory explanation of its action in this particular has as yet been given. It has been demonstrated to have decided value as an **antiseptic**, and this is thought to be due to its well-known hygroscopic properties, in consequence of which water is withdrawn from the microbes. It is destructive to parasites, both intestinal and external.

THERAPEUTICS OF GLYCERIN.

External.—Glycerin is employed to a considerably greater extent externally than as an internal remedy. It is an extremely useful emollient, and as it does not evaporate or turn rancid, and is readily absorbed when rubbed into the skin, it has many advantages as a vehicle for the application of active medicinal agents. Applied to the mucous membrane by means of a camel's hair brush, pure glycerin affords much relief in acute coryza. Glycerin, diluted one-half with distilled water, is of great service in relieving the dryness of the lips, mouth and tongue in fevers. A solution of morphine in glycerin is sometimes applied with a brush to the fauces to allay the irritating cough of phthisis. A mixture of glycerin, crystallized sugar, and whiskey, which is allowed to trickle down the throat, may also be given for the same purpose. Among the many other useful applications of glycerin are the following: For chapped face and hands, sore nipples, and piles it may be combined with witchhazel water and rose water; for excoriations, erythema, and superficial burns, with lime water and rose water; for erythematous or vesicular eczema, burns, and seborrhœa, especially about the axilla and the genital organs, with phenol, witchhazel water, and either bismuth subnitrate or sodium bicarbonate; for freckles and other skin pigmentations with lactic acid and rose water, and for pruritus, eczema and urticaria with creosote and oil of peppermint. The latter combination may also be used, in the form of a spray, in nasal catarrh, pharyngitis and laryngitis. The glycerite of tannin makes an excellent astringent application for sore throat (particularly chronic follicular pharyngitis), relaxed mucous membranes, and other conditions, and it is said that the daily topical use of glycerin is capable of causing a steady reduction in the size of hypertrophied tonsils. The glycerite of starch is frequently employed as a vehicle for the application of astringents to the eye, and glycerin and its preparations are also much used in ear affections. Glycerized collodion (glycerin, 2; collodion, 100), which is extremely supple and does not crack and scale off from the skin, is less painful than pure collodion, and forms a serviceable protective for fissures and abrasions. For fissured nipples a liniment composed of one part of tincture of benzoin to six or eight of glycerin is also highly recommended. Glycerin is a convenient vehicle for the absorption of drugs by the skin, and one of the most common applications of this use is in the case of belladonna, the local anodyne action of which may be obtained by rubbing it in mixed with glycerin. Glycerin, either alone or combined with an astringent or sedative, may be employed for the prevention of bed-sores. Glycerin, as well as boroglycerin (*see* p. 77), is used extensively in various local applications in the treatment of diseases of women, and in congested states of the genital organs it is of special service by causing, on account of its affinity with water, an abundant serous transudation. For the use of glycerin with kaolin see Kaolin (p. 406).

Internal.—On account of its sweetness glycerin is employed to a considerable extent as a flavoring agent. Large doses of glycerin sometimes cause purgation, but it is not a reliable remedy for this purpose, and alone is seldom given by the mouth as a laxative, except perhaps in the case of hæmorrhoids, upon which it is asserted to have a peculiarly soothing effect. To produce efficient cathartic action it is advised that it should be combined with magnesium sulphate or carbonate, rhubarb, and tincture of belladonna. As a laxative, however, it is much more frequently administered by the rectum, where 4 to 8 c.c. (1 to 2 fl. dr.) produces a prompt evacuation, without pain or other disturbance; and the most convenient way to use it is in the form of the glycerin suppository. The glycerin is said to pass upwards as far as the sigmoid flexure, and even beyond. While, from its contact with the epithelial walls, it may thus perhaps increase the peristalsis of the greater part of the large intestine, the local irritation of the lower portion of the rectum is itself no doubt sufficient to set up reflex movement of the bowel. Enemata of glycerin diluted with water, or, better, of glycerin combined with flaxseed tea, in the proportion of one to four, are of considerable service in dysentery; relieving the tenesmus. Glycerin has been advised by some as a food in conditions of malnutrition, but, although it forms part of the composition of ordinary fats, it proves, as a rule, a very inferior substitute for cod liver oil and other fatty substances. On theoretical grounds it has been employed in the treatment of diabetes, but it appears to have little or no practical value in that disease. It was formerly used to a considerable extent by diabetics as a substitute for sugar, but its sweetness is of a kind rather disagreeable to many, and its place has now largely been taken by saccharin and levulose. Glycerin, it has been found, is capable of destroying trichinæ in the intestinal tract, and it is therefore a remedy of distinct value in cases of trichiniasis. Among other conditions in which it has been used internally may be mentioned acne, vomiting of pregnancy, gallstone disease, and nephrolithiasis.

IRISH MOSS.

CHONDRUS.—Chondrus. (Irish Moss. Carragheen.) **Dose,** in decoction, **15 gm. (4 dr.).**

ACTION OF IRISH MOSS.

Irish moss is demulcent and somewhat nutrient, though the gum which enters largely into its composition does not digest very readily.

THERAPEUTICS OF IRISH MOSS.

The decoction (made by boiling 750 c.c. (1½ pints) of water with 15 gm. (½ oz.) of the moss down to 500 c.c. (1 pint)) was formerly much more generally used than at present, in bronchial affections, diarrhœa, dysentery and irritation or inflammation of the genito-urinary tract. Whatever beneficial effect it may have had was probably due to its protective qualities, and also possibly to some extent to the influence on nutrition of the minute quantity of iodine in it. When made into a jelly it is a pleasant article of diet. At one time this was supposed to constitute an important food in illness, but it is really of little practical value, as only $\frac{1}{2}$ to $\frac{1}{30}$ of the jelly is solid matter; the rest being water. Irish moss is also used as a vehicle in preparations of bone marrow.

MARSHMALLOW.

ALTHÆA.—Althæa. (Marshmallow.)

ACTION OF MASHMALLOW.

Marshmallow is demulcent, emollient and slightly nutritious.

THERAPEUTICS OF MARSHMALLOW.

It is a useful demulcent for irritation and inflammation of mucous membranes. It is held in popular esteem, especially as a remedy for sore throat, and the confections of it are serviceable in scarlet fever and diphtheria, as well as in ordinary pharyngitis. A decoction is sometimes given for gastric irritation and used locally in irritations of the vagina and of the rectum. An excellent emollient poultice is made from the powdered root, and, combined with benzoinated lard, marshmallow is employed as a bland dressing in cutaneous affections. It is a constituent in blue mass and in phosphorus pills, to which it serves to give the proper consistence. It is thought to be slightly diuretic and in the form of a fresh infusion it has been given to children, especially in Bright's disease.

GELATIN.

GELATINUM.—Gelatin.

Preparation.

Gelatinum Glycerinatum.—Glycerinated Gelatin.

ACTION OF GELATIN.

Gelatin is a demulcent and styptic, and is also believed to be to some extent nutrient, as it increases vital action in the same direction, though not in the same degree, as albumin.

THERAPEUTICS OF GELATIN.

It is used as a basis for capsules, lozenges, bougies, suppositories and pessaries, as a coating for pills, and as a protective covering in certain diseases of the skin. An admirable basis for throat pastilles is the following, known as glycogelatin: gelatin, 2; glycerin, 5; orange flower water, 5; colored with carmine. Each should weigh 2 gm. (30 gr.), and any desired medicinal agent may be incorporated in such pastilles. As a covering for the skin Unna's zinc-gelatins, which are dispensed in small cubes, are extremely serviceable. After being melted they are painted over the affected surface, and the part is then covered with a layer of cotton wool. Perhaps those in most frequent use are zinc gelatin with ichthyol, 1 to 5 per cent., with phenol, 1 to 3 per cent., with sulphur, 5 per cent., and with resorcinol, 2 per cent. As an antidote, gelatin is of especial value against iodine, bromine and the alums, but requires too much time for its preparation, as for this purpose it should be broken up and reduced to the consistency of honey by being soaked for half an hour in water. Sterilized gelatin in solution has been administered subcutaneously to increase the coagulability of the blood in aneurism.

STARCH.

AMYLUM.—Starch. Corn Starch.

Preparation.

Glyceritum Amyli.—Glycerite of Starch.

ACTION OF STARCH.

Starch is demulcent and nutritive. It and grape-sugar are the chief members of the non-nitrogenous group of alimentary principles known as carbohydrates. In the animal economy starch undergoes digestion by ptyalin, pancreatin and the secretion of the intestinal glands, which convert it first into soluble dextrin and then into grape-sugar, in which form it passes into the blood. The non-nitrogenous principles (starches, sugars and fats) are mainly concerned in heat-production. The excessive consumption of starchy food delays tissue-metamorphosis, causes a redundancy of fat, and often gives rise to acidity and flatulence. Undigested starch passes into the fæces, and the urine may become saccharine.

THERAPEUTICS OF STARCH.

Medicinally starch is inert, and it is used principally on account of its mechanical properties, which make it a good basis for dusting powders and insufflations. The mucilage (1 to 40), which is made by gradually adding the starch and then boiling and stirring for a few minutes, is a convenient basis for enemata. It may also be used as a basis for ointments and to suspend insoluble powders or oils, though it is open to the objection that it keeps badly. The glycerite is a very soothing local emollient, and is also employed as a basis for suppositories. A starch poultice (made by enclosing clear starch, prepared as in the laundry, between folds of soft muslin) is also a very soothing application in inflammatory conditions of the eye or lids. Mixed with glue, starch makes an excellent stiff bandage for surgical purposes. Starch is employed as an antidote in poisoning by iodine or bromine.

SUGAR OF MILK.

SACCHARUM LACTIS.—Sugar of Milk. (Lactose.)

ACTION OF SUGAR OF MILK.

Sugar of milk is a non-nitrogenous, bland article of diet, which is less apt to ferment in the gastro-intestinal tract than cane- or grape-sugar. It is stated by some authorities to be a very active diuretic, especially when cardiac dropsy is present.

THERAPEUTICS OF SUGAR OF MILK.

Being very hard, and also but slightly deliquescent, it is a valuable excipient for powders requiring the minute subdivision of their medicinal constituent and as a diluent to bring extracts to the required strength. It has been used as a carbohydrate food in consumption and other wasting diseases, and, on account of its smaller liability to ferment, is preferred to cane-sugar for the sweetening of infant's food. It is also a serviceable food in acute febrile diseases, and, being tasteless and easily soluble in most fluids, it may often be taken with advantage to the extent of 30 to 60 gm. (1 or 2 oz.) a day. According to the observers mentioned above, it is a diuretic which may be employed with good results in cardiac dropsy. It is said, however, that its diuretic action is but very slight in cases where extensive renal disease exists.

Division V.—DRUGS ACTING ON THE SKIN.

While the drugs described in the preceding Division act on the cutaneous blood-vessels, in addition we have—

A. Diaphoretics, or drugs which increase the amount of perspiration. These may do this: (1) By affecting the circulation in the skin. This may be locally (by local irritation) or systemically. In the latter case the action may be an indirect one, and due to a rise of general blood-pressure if the cutaneous vessels are not at the same time constricted; or a direct one, due either to stimulation, direct or reflex, of the central dilator mechanism of the cutaneous vessels, or to paralysis of the vaso-constrictor mechanism of these vessels. (2) By directly augmenting the secretory activity of the cells of the sweat glands, either through stimulation, direct or reflex, of the sweat centres in the spinal cord, or through peripheral stimulation of the terminations of the nerves in the glandular cells themselves. As it is difficult to decide whether drugs acting on the vessels do not affect the other parts of the mechanism, and also whether a drug acts on the gland-cells or on the nerve endings, diaphoretics will be considered under two headings only: (a) those acting peripherally, and (b) those acting centrally. These are differentiated by observing whether the drug acts on a part of the skin after division of the nerves going to it, or whether it acts after destruction of the spinal cord.

(*a*) *Diaphoretics acting peripherally:* **Pilocarpine** greatly increases the amount of sweat, acting on the nerve terminations in the gland-cells, but not on the vessels. **Nicotine** also acts peripherally. Local applications of **warmth,** and **Alcohol** taken internally perhaps act in the same way in addition to their vascular action.

(*b*) *Diaphoretics acting centrally:*

(1) **Antimony salts.**
(2) **Ammonium acetate.**
(3) **Ammonium citrate.**
(4) **Ipecacuanha.**
(5) **Opium.**
(6) **Camphor.**

(*c*) *Diaphoretics whose mode of action is doubtful:* **Potassium citrate** and **acetate,** senega, cubeb, colchicum, salicin, lobelia, arnica and aconite. Such domestic remedies as boneset and hoarhound are usually classed as diaphoretics, but their efficiency is chiefly due to the large amount of hot water employed in their preparation and administration. All these, except the first two, are very feeble.

When a diaphoretic acts very powerfully it is called a **Sudorific.**

B. Anhidrotics, or **Antihidrotics,** drugs which diminish the amount of perspiration. The part on which these act is determined in the same way as in the case of diaphoretics.

(*a*) *Anhidrotics acting peripherally:* **Atropine** is very powerful; it acts on the terminations of the nerves in the glands, and **hyoscyamus** and **stramonium** apparently act in the same way. The local application of **cold** has a similar action.

(*b*) *Anhidrotics the mode of action of which is doubtful:*

(1) **Acids.**
(2) **Nux vomica.**
(3) **Quinine.**
(4) **Picrotoxin.**
(5) **Zinc salts.**
(6) **Salicylic acid.**
(7) **Camphoric acid.**

Therapeutics.—Diaphoretics are used for the following purposes: (1) To remove fluid from the body, as by causing the absorption of exudates. (2) To relieve diseased and overtaxed kidneys; for this purpose pilocarpine is much used. (3) To remove poisons introduced from without or formed in the body. Pilocarpine is also used to promote excretion by the sweat in uræmia and similar conditions. (4) To re-establish disturbed circulation in the skin, in order to relieve internal congestions, break up an incipient "cold," bring out the rash in exanthemata, promote defective nutrition of the skin in certain cutaneous diseases, etc. The increased vascularity of the skin is also made use of to facilitate the absorption of local medicaments, such as ointments. Diaphoretics act as mild antipyretics. (5) To increase the alkalinity of the tissues, as in gout, oxybutyric acid coma (diabetes), etc. For this purpose drugs which directly stimulate the glandular activity are required, as the sweat is acid only when produced in this manner. It has been shown that an injection of pilocarpine is so effective in removing acid that it will render the urine of a healthy person markedly alkaline. In general, the sweat which results from increased circulation contains less solid matters and is more alkaline, while that resulting from direct action on the glands is more concentrated and less alkaline. This is the character of the *cold sweat* which carbon dioxide produces by stimulating the sweat centres, and which is often of serious import in the course of a disease, as indicating asphyxia. Certain drugs when taken internally are excreted in the sweat. Among them may be mentioned iodine, iodides, and tartaric, succinic and benzoic acids, the latter in the form of hippuric acid.

Anhidrotics are employed to a limited extent either for general conditions, as phthisis, or for local conditions, as hyperidrosis of the hands or feet. Little or nothing is known of the effect of drugs on the sebaceous secretion, though iodides and some other substances are excreted in the sebum.

Certain drugs, when taken internally in large doses, **produce a rash** on the skin, possibly because in the course of their excretion through the skin they irritate it. Such are—

(1) **Copaiba.**
(2) **Cubeb.**
(3) **Bromides.**
(4) **Iodides.**
(5) **Turpentine.**
(6) **Belladonna.**
(7) **Hydrated chloral.**
(8) **Opium.**
(9) **Quinine.**
(10) **Salicylic acid.**
(11) **Arsenical salts.**
(12) **Acetanilide.**
(13) **Antipyrine.**
(14) **Acetphenetidin.**
(15) **Chloralformamide.**
(16) **Antitoxins.**
(17) **Serums.**
(18) **Silver salts** (discoloration).
(19) **Sulphonethylmethane.**
(20) **Sulphomethane.**

The following quite rarely produce an eruption:

(1) **Iron.**
(2) **Strychnine.**
(3) **Creosote.**
(4) **Mercury.**
(5) **Veratrum.**
(6) **Aconite.**
(7) **Digitalis.**
(8) **Sulphur.**
(9) **Antimony.**
(10) **Santonin.**
(11) **Cod liver oil.**

DIAPHORETICS.

PILOCARPUS.

1. **PILOCARPUS.**—Pilocarpus. (Jaborandi.) **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Pilocarpi. — Fluidextract of Pilocarpus. **Dose, 2 c.c. (30 ♏).**

2. **PILOCARPINÆ HYDROCHLORIDUM.**—Pilocarpine Hydrochloride. **Dose, 0.010 gm. = 10 milligm. (1/5 gr.).**

3. **PILOCARPINÆ NITRAS.**—Pilocarpine Nitrate. **Dose, 0.010 gm. = 10 milligm. (1/5 gr.).**

ACTION OF PILOCARPUS.

External.—None.

Internal. *Gastro-intestinal Tract.*—Pilocarpine, which is promptly absorbed, is a glandular stimulant of extraordinary power. Its first effect is seen in a **marked increase** of the **saliva,** which contains an abundance of salts and ptyalin, and will readily convert starch into sugar. There is a feeling of warmth in the mouth, and often a sensation of tenseness about the salivary glands. The seat of the stimulation is the **terminations** of the **secretory nerves.** That it does not reside in the cells is shown by the fact that the action of the drug is instantly antagonized by atropine, which acts upon the nervous structures alone, and not upon the secretory cells; and that it is not central in character is evident from the fact that section of the secretory nerves does not materially alter the action. Nausea, retching and vomiting are occasionally observed, and there is always some increase in the gastric and pancreatic secretions. Whether there is any increase in the intestinal secretion is still unsettled, though this seems highly probable. **Peristalsis** is **increased** by the contraction of the intestinal muscle from the stimulation of its peripheral nervous apparatus. Unstriped muscle generally, with the exception of that of the blood-vessels, appears to be thrown into contraction, but this action is more marked in the bowel than elsewhere; so that repeated diarrhœic evacuations occur, accompanied with more or less colic. This muscular action also takes place independently of the central nervous system, and is antagonized by atropine in the same way as the effect on the glandular secretions. The secretion of bile is not directly affected.

Eye.—**Myosis** (contraction of the pupil) and spasm of accommodation are produced through stimulation of the motor oculi terminations. The intra-ocular tension is reduced, after a temporary increase; myosis being generally attended with lowered tension.

Skin.—Shortly after the augmentation of the salivary secretion begins, there follow a flow of tears and **excessive perspiration.** The effect on the sweat glands is so pronounced as to leave no question that pilocarpus is the **most efficient diaphoretic of all known drugs.** The general increase in the secretions is found to be mainly due to water. Although the solids are increased also, yet, owing to the excess of fluid poured out, their percentage is diminished. After a single subcutaneous dose of pilocarpine the water lost in the sweat, saliva, mucus, and other secretions may amount to 3785 c.c. (1 gallon). The loss of weight is naturally very great also, and this has been set down at from 2 to 4 kilogrammes (4½ to 9 pounds). The mucous glands of the mouth, throat, nose and deeper respiratory passages, as well as the ceruminous glands of the ears, all participate in the activity induced by the pilocarpine stimulation. The effect upon the secretion of milk is doubtful. Under a course of pilocarpus the hair grows more luxuriantly, but it becomes quite coarse.

Circulation.—In man pilocarpine is found to give a marked acceleration to the pulse, with increased blood-pressure and later with arhythmia. This is attributed to vagus paralysis, though the rise of blood-pressure is believed to be partly due to a stimulation of the vaso-motor centres. Under large doses there follow muscular slowing and weakening of the heart, with **fall of blood-pressure**; and this action is judged to be on the cardiac muscle directly. In rabbits, it is stated, there is a primary vagus stimulation, which is shown by slowing of the heart and fall of blood-pressure, and this action sometimes occurs in man also. The increased activity of the glands is accompanied by an acceleration of the blood current through them, with dilatation of the vessels, and this is believed to be probably not due to the direct action of the drug on the latter, but simply a result of the stimulus imparted to the glands. After pilocarpine there is frequently noticed a **redness of the skin**, especially of the face, and this is no doubt due to the **vascular dilatation** accompanying the increased activity of the sweat glands. The sugar of the blood has been found increased, a result attributed to the action of pilocarpine on the terminations of the nerves in the liver which regulate the glycogenic function of that organ.

Respiration.—The respiration is often quick and dyspnœic, and râles may be heard over the bronchi, denoting an accumulation of mucus in them; the bronchial secretion being markedly augmented. The effect on the respiration of ordinary doses is merely an indirect one, resulting from changes in the circulation which diminish the amount of blood passing through the lungs and tend to produce asphyxial dyspnœa.

Central Nervous System.—In experiments on animals it is found that the action here is weak and appears late; being entirely overshadowed by the peripheral actions. It is described as follows: The effects are mainly depressing. Vasomotor paralysis is a rather early and prominent symptom; it leads to dyspnœa. Later, the respiratory centre is also depressed. Œdema of the lungs (consisting rather in the aspiration of bronchial effusion than in a true serous effusion), consequent on the weakened heart and obstruction of the bronchi by mucus, is a frequent occurrence. The motor centres, especially those of the cord, show some stimulation (increased reflexes, tremors, convulsions), and later paralysis.

Urinary Organs.—The urine, like the bile, does not seem to be affected directly, although it may be reduced in quantity or otherwise modified by the withdrawal of a large amount of fluid from the body by the sweat and other secretions. The bladder muscle participates in the general contraction of unstriped muscular fibre induced by the drug, and repeated evacuation and straining may occur. Pilocarpine is excreted unchanged in the urine.

Uterus.—The spleen and bronchi contract under the influence of pilocarpine upon unstriped muscle, and the uterus is supposed to be affected in the same manner. In occasional instances abortion has been attributed to the action of the drug.

Temperature.—In consequence of the hyperæmia of the skin the temperature is apt to be temporarily elevated, but there soon follows a decided fall, which is apparently due in great measure to the evaporation of the perspiration. The decline in body-heat is maintained on an average for about four and a half hours.

The most important effects of pilocarpine on the system are the diaphoresis, the salivation, and the myosis. The antagonism to atropine is complete with both glands and muscles. The alkaloid pilocarpine is more generally employed than pilocarpus itself, as it is more prompt and efficient in its action, as well as less liable to disagree with the stomach. Children usually bear large doses of it well.

The alkaloid jaborine, having an action like that of atropine, opposes the effects of pilocarpine, but although the amount of it varies in different specimens of pilocarpus leaves, there is never a sufficient quantity to entirely overcome the action of the principal alkaloid of the drug.

THERAPEUTICS OF PILOCARPINE.

External.—For promoting the growth of the hair an ointment composed of pilocarpine hydrochloride, 1; petrolatum, 60; lanolin, 60; may be used, or a lotion: Pilocarpine hydrochloride, 1; quinine hydrochloride, 4; glycerin, 60; rose water, 180. The following, applied with friction, is more stimulating to the scalp: Fluidextract of pilocarpus, 15; soap liniment, 15; cologne, 60. Pilocarpus and its preparations also have the effect of rendering the hair darker in color. The fluidextract has been employed as a local application in eczema and erysipelas. Pilocarpine is used topically as a myotic in many eye affections. Lozenges containing .001 gm. ($\frac{1}{40}$ gr.) are said to relieve dryness of the throat.

Internal.—Pilocarpine may be used whenever a prompt diaphoretic effect is desired. It is most commonly employed to produce sweating in cases of Bright's disease. The usual practice is to administer .01 gm. ($\frac{1}{6}$ gr.), or more, of pilocarpine hydrochloride or nitrate, in the evening, aiding the sweating by wrapping the patient, who should be naked, in warm blankets, applying heat to the feet, and administering hot drinks. As soon as the sweating has ceased he should be rubbed dry and left in a dry blanket. In this affection the drug is often of great service by relieving the kidneys, by eliminating toxins from the blood and diminishing the inflammatory condition in the kidneys by lowering the blood-pressure. On account of its depressing action on the heart, it should always be used with great caution when there is any cardiac disease present, and alcohol or strychnine may often be administered with advantage to guard against depression of that organ. By some, pilocarpine is never employed in chronic parenchymatous nephritis, and the opinion is held generally that it is contra-indicated in the nephritis of middle or advanced age associated with cardiac changes. Theoretically it is the most prompt and efficient remedy at our disposal in uræmia, and in many instances it is practically of great service. In dropsy due to organic disease of the heart it is generally too depressing, and fatal results may attend its use. It may be used in pleurisy with effusion, but is not so efficient as some other remedies. Injected subcutaneously every second day, it has proved successful in the treatment of some cases of catarrhal jaundice of a persistent type. Its administration by the same method has been highly recommended as a preventive and curative measure in the early stages of erysipelas, and has been found effective in cases of obstinate aural vertigo. Deafness resulting from disease of the auditory nerve or its terminations is sometimes relieved by pilocarpine, and the drug is often given internally for deafness due to *otitis media sicca.* Locally applied, pilocarpine is of service to relieve pain after excessive use of the eyes, and in small doses internally has been shown to be a good remedy in tobacco and alcoholic amblyopia. Among other diseases of the eye in which it has been employed are detachment of the retina, chronic iritis, keratitis, hæmorrhages into the vitreous, hæmorrhages and exudations of the retina, glaucoma, atrophic choroiditis, and commencing atrophy of the optic nerve. When given hypodermatically it is sometimes successful in stopping hiccough, and also in arresting paroxysms of spasmodic asthma. Efficient aid to the action of iodides and mercurials in the removal of exudations has been found to be rendered by the use of pilocarpine or pilocarpus, which is here given chiefly for the purpose of increasing the rate at which the exudates liquefied by the agents mentioned are taken up and excreted. In the case of gummata it is advised that the adjuvant remedy should be exhibited once or twice a day. For the attempted removal of inflammatory deposits such as those met with in chronic pneumonia and chronic pleurisy, it is thought preferable to give pilocarpine for three or four days at a time, and then to discontinue its use until the following week. The dosage and frequency of administration must be regulated by the degree of action, and an amount which will cause but little sweating and salivation is said to suffice. In subacute and muscular rheumatism, as well as in dry and scaly skin eruptions, it may often be used with great advantage. Injected subcutaneously, pilocarpine is sometimes successfully employed as an antidote in belladonna or atropine poisoning.

TOXICOLOGY.

Death very rarely results from the use of pilocarpus or its alkaloid. When it does occur, it is by paralysis of the heart or œdema of the lungs. *Treatment.*—Atropine is a physiological antidote. In addition to its use, the general treatment of alkaloidal poisoning is called for.

ANTIMONY.

ANTIMONII ET POTASSII TARTRAS.—Antimony and Potassium Tartrate. (Tartar Emetic. Tartarated Antimony.) **Dose** (expectorant), **0.005 gm. = 5 milligm. ($\frac{1}{10}$ gr.)**; (emetic) **0.030 gr. = 30 milligm. (½ gr.).**

Preparations.

1. **Syrupus Scillæ Compositus.**—Compound Syrup of Squill. (Hive Syrup.) **Dose, 2 c.c. (30 ♏).**
2. **Vinum Antimonii.**—Wine of Antimony. **Dose, 1 c.c. (15 ♏).**

ACTION OF SALTS OF ANTIMONY.

External.—They are powerful **local irritants.** Tartar emetic produces a pustular eruption. If it is persistently rubbed on the skin, the pustules caused by it may become confluent and form small abscesses, and, later, extensive necrosis and ulceration of the integument may be induced. A solution of antimony chloride in hydrochloric acid, is a severe **caustic.**

Internal. *Alimentary Canal.*—Antimony acts very much like arsenic, though differing from the latter in the severity of its local action and in being absorbed more slowly. In large doses by the mouth, or if injected into the circulation, its effects are found to be practically identical with those of arsenic, but **vomiting** is always a **prominent symptom,** the poison being rapidly excreted into the alimentary canal. The only result of very small doses of tartar emetic is the production of some perspiration. In somewhat larger amounts, by its direct action on the walls of the stomach, it causes nausea and vomiting with marked prostration and the usual accompaniments of emesis, such as salivation, sweating and quickened pulse. Like other antimonial preparations, it is irritant to the intestine if given in sufficient quantity. A round mass of metallic antimony was formerly known as the "family pill," because it could be repeatedly used as a laxative. In poisonous doses tartar emetic gives rise to violent and continuous vomiting, the vomit, after the ordinary contents of the stomach have been evacuated, consisting of mucus, which eventually may have blood mixed with it. With the vomiting are associated profuse watery diarrhœa, great muscular weakness, and collapse, with cold perspiration, clammy skin, and cyanosis of the face and extremities. This drug when thrown directly into the blood also produces vomiting, but it is found that much larger quantities are required for this than when it is given by the mouth. Moreover, a portion of the antimony which is injected intravenously is carried to the stomach and intestine, where it causes local irritation. Some have believed that the emesis is due to action on the medulla, but from the facts just mentioned it would appear that this is attributable entirely to its effects as a gastric irritant. It is true that, when injected into the circulation, it may have an emetic effect even if the stomach is replaced by a bladder, as has been shown by experiment; but in explanation of this it has been suggested that although the antimony cannot act on the stomach under these circumstances, it may induce vomiting by causing irritation of some other part of the alimentary tract. While large quantities affect the gastro-intestinal tract much in the same way as arsenic, causing hyperæmia and swelling of the mucous membrane, medicinal doses do not cause any such effects. Even with large doses, however, the intestine may remain unaffected, both because antimony is, as has been mentioned, absorbed more slowly than arsenic, and because the larger portion of the poison is usually gotten rid of by the violent vomiting excited.

Heart and Circulation.—Antimony is a direct **depressant** to the **cardiac muscle.** The temporary acceleration of the pulse is simply one of the effects of the vomiting, and is succeeded by a diminution in both the frequency and force of the beat of the heart. The final stoppage of the organ is found by experiment to take place in diastole. There is no evidence that the cardiac nerves are affected. There is a continuous fall in blood-pressure, due in some measure to the weakness of the heart, but principally to the effect of the drug on some part of the vaso-motor system. The peripheral nerves and muscle of the vessels are known to be implicated, though it is uncertain whether or not the vaso-motor centre shares in the action.

Respiration.—Like the pulse, the respiration is often quickened at first, and may be shallow and irregular from the nausea, but in cases of poisoning it becomes slow and labored, and eventually ceases along with the heart. The weakening of this function is believed to be chiefly due to the disturbance of the circulation and the irritation of the alimentary canal, though the respiratory centre may possibly be in some degree directly acted upon.

Nervous and Muscular Systems.—In the frog the central nervous system has been shown to be directly depressed by antimony. This is thought to be probably the case in mammals also, though the effects of the poison on the circulation and alimentary canal render the true nature of the nervous action obscure. There is good authority for stating that the depression and collapse resulting from the drug are due to the gastric irritation and slowed circulation, and not to any involvement of the peripheral nerves and muscles, as has been believed by some. In the frog the voluntary muscular tissue is found to be weakened to some extent, but only after large doses and at a late stage of the poisoning.

Temperature.—Antimony, in considerable doses, produces a **marked reduction** of temperature. This is attributed to the slowness of the circulation, the general depression and collapse, and the profuse sweating.

Secretion and Excretion.—Such secretions as the sweat, the saliva, and the mucus of the respiratory tract are increased by antimony, not in consequence of any direct action upon the glands, but simply as a result of the emesis caused by the drug. Its action on the urinary secretion is not very marked. The urine is sometimes more or less increased, and sometimes diminished or even entirely suppressed. This has been explained by the suggestion that there is a temporary stimulation of the renal epithelium, but that later, when a larger amount of the antimony has been absorbed, an acute irritation of the kidneys is excited. The prolonged use of the drug, as in the case of arsenic, is liable to induce fatty degeneration of many organs and abrogation of the glycogenic function of the liver, while the nitrogen of the urine is increased. Very small quantities of antimony, given repeatedly, are stated, however, to augment the hepatic glycogen and fat, without apparently altering the nitrogen of the urine. Antimony is absorbed from the gastro-intestinal tract and very slowly from the skin, and it passes into the tissues much more gradually than arsenic; consequently doses can be chosen whose only action is to produce nausea, or, if somewhat larger, vomiting. After absorption it is stored in considerable amount in the liver. It is excreted into the stomach and intestine, in the urine, and also probably in the bile and milk.

THERAPEUTICS OF SALTS OF ANTIMONY.

External.—A solution of antimony chloride, known as Butter of Antimony, was once used as a caustic, but its employment has been abandoned, as the sore produced is difficult to heal.

Internal.—Tartar emetic was at one time given in a large number of conditions which it is unnecessary to enumerate, as, on account of its depressing effects, it has been superseded by other remedies. Almost the only class of affections in which it is now employed to any extent is diseases of the respiratory passages, in which it has a limited field of usefulness. In commencing bronchitis it is occasionally given until vomiting occurs, and then continued in smaller doses and at longer intervals. More commonly, in the early stage of acute bronchitis, it is used in doses insufficient to produce emesis. Here it serves to promote secretion, diminish fever, induce diaphoresis, and hasten the elimination of inflammatory products. When a free secretion of bronchial mucus has once been established, it should as a rule be discontinued, as after that it is too depressing to constitute a satisfactory expectorant. It is also a useful remedy in the first stage of acute nasal and pharyngeal catarrh. It is not a suitable preparation for infants or very young children, and compound syrup of squill (Coxe's hive syrup), which is a domestic remedy for croup, has been known to prove fatal. When an emetic is required in laryngitis, bronchitis, or other acute inflammation of the respiratory tract, ipecacuanha is usually preferable. In acute inflammatory and febrile diseases, other than those of the air-passages (provided there is not much irritability of the stomach), minute doses of tartar emetic (.004 gm.; $\frac{1}{16}$ gr.) are still highly spoken of by some writers, and impending attacks of malarial fever are said to be sometimes successfully aborted by emetic doses of antimony and ipecacuanha. As a diaphoretic, tartar emetic has been very largely supplanted by pilocarpine.

TOXICOLOGY.

Acute Poisoning.—The symptoms resemble those of arsenical poisoning (*see* p. 224). *Post-mortem.*—There is hyperæmia, tumefaction and erosion, with ecchymoses, of the gastric and intestinal mucous membranes. Pustules may be found in the mouth, œsophagus, stomach and small intestine, and there may be congestion or inflammation of the lungs.

Treatment.—Emetics are seldom required, but if the poison does not cause free vomiting, the stomach should be washed out or emetics administered subcutaneously (apomorphine hydrochloride) or by the mouth (zinc sulphate). A purge may also be given to remove the poison in the bowel. Tannic acid, in repeated doses of 2 gm. (½ dr.), is used to precipitate the antimony in the stomach, and the tannate thus formed should be washed out. A form of tannic acid which is usually readily obtainable is strong tea, which is also serviceable as a stimulant for the collapse. Mucilaginous drinks may likewise be given freely, and stimulants by hypodermatic injection, as well as the external application of heat, are generally called for.

Chronic Poisoning is very rare, and it is difficult to recognize, as the symptoms do not present any very definite characteristics. Among them are described headache, dizziness, depression, indistinct sight, nausea and vomiting, dyspepsia with more or less gastric pain, diarrhœa, loss of flesh, albuminuria, general weakness and exhaustion, and finally collapse. As the symptoms resemble those of acute gastro-intestinal catarrh, poisoning with small, repeated doses of antimony is sometimes resorted to criminally, and an instance of the use of the drug for homicidal purposes has recently been the subject of judicial inquiry. Pustular eruptions, it is said, have been observed from the prolonged internal use of tartar emetic.

Post-mortem.—Antimony is said to be found in the liver, kidneys, spleen, bones and muscles, and there is also fatty degeneration of the viscera, especially the liver.

THOROUGHWORT.

EUPATORIUM.—Eupatorium. (Thoroughwort. Boneset.) **Dose, 2 gm. (30 gr.).**

Preparation.

> **Fluidextractum Eupatorii.** — Fluidextract of Eupatorium. **Dose, 2 c.c. (30 ♏).**

ACTION OF THOROUGHWORT.

Thoroughwort is tonic and mildly laxative. It is also diaphoretic in infusion, but the diaphoretic properties of the preparation are chiefly due to its hot water.

THERAPEUTICS OF THOROUGHWORT.

It is, like many other substances of vegetable origin, a domestic remedy for the commencement of catarrh, influenza, or muscular rheumatism.

MARRUBIUM.

MARRUBIUM.—Marrubium. (Horehound.) **Dose, 2 gm. (30 gr.).**

ACTION OF HOREHOUND.

Horehound, used as a decoction or an infusion, is in moderate doses diuretic and diaphoretic, and in large doses laxative. It is probably also a bitter stomachic.

THERAPEUTICS OF HOREHOUND.

It may be given to increase the action of the skin and kidneys, but its effects are not marked. Horehound candy, slowly dissolved in the mouth, relieves the relaxed throat of public speakers.

DIVISION VI.—SUBSTANCES ACTING ON THE URINARY SYSTEM.

1. *Drugs Increasing the Quantity of Urine Secreted.*—These are called diuretics. The kidneys are susceptible to a variety of influences. Thus, anatomically they present two distinct varieties of epithelium and have an extremely abundant supply of vessels and vaso-motor nerves, while the activity of the organs is profoundly affected by variations in the quantity of blood flowing through them. In the present state of our knowledge it is impossible to say in just what manner many diuretics act. A considerable number of them, no doubt, are effective in more ways than one, and the following table, taken from Brunton but somewhat modified, presents the various ways in which these agents probably act:

- Raise arterial pressure.
  - Generally.
    - Increased cardiac action.
      - **Digitalis,**
      - **Caffeine,**
      - **Alcohol,**
      - **Strophanthus,**
      - **Sparteine,**
    - General vascular contraction.
      - **Digitalis,**
      - **Squill,**
      - **Erythrophlœum,**
      - **Convallaria,**
      - **Strychnine,**
      - **Cold to skin.**
  - Locally in kidney.
    - Contract efferent vessels.
      - Act on vaso-motor centres.
        - **? same as above.**
      - Locally on kidney.
        - **Broom,**
        - **Caffeine** (large doses),
        - **Buchu,**
        - **Uva Ursi,**
        - **Juniper,**
        - **Turpentine,**
        - **Copaiba,**
        - **Cantharides.**
    - Dilate, chiefly locally, renal vessels.
      - **Caffeine,**
      - **Urea.**
- Act on secreting nerves or renal cells.
  - Increase water excreted.
    - **Urea,**
    - **Caffeine,**
    - **Theobromine Sodio-salicylate,**
    - **Calomel.**
  - Increase water and solids excreted.
    - **Colchicum,**
    - **Potassium Hydroxide,**
    - **Potassium Acetate,**
    - **Potassium Citrate,**
    - **Potassium Nitrate,**
    - **Sodium Citrate and other salines.**

Therapeutics.—Diuretics are used chiefly for the following purposes: (1) To maintain the action of the kidneys. Diminished urinary excretion may be purely functional in its origin, as in fevers. In these it is essential that the action of the kidneys should be maintained, and the free use of water is often very serviceable for this purpose. The ingestion of large quantities of water greatly increases the urinary flow, and may increase not only the amount, but also the solids, of the urine. Investigation has shown that when the tissues are full of the products of disintegration the effect of water is very marked, but that upon the wasting processes of the body it exerts no influence; hence, while it may not be possible to produce tissue-disintegration by water, there would seem to be no question that water is capable of washing out the retained products of tissue change. This naturally renders it of value in various diseases. Intestinal lavage (enteroclysis) with normal saline solution, by means of the rectal irrigator, has been found one of the best and most certain of diuretics. Diuretics are used in cardiac and pulmonary affections when, owing to the general vascular disturbance, the quantity of urine becomes diminished. In diseased conditions of the kidney itself the maintenance of the urinary excretion is urgently demanded, but on account of organic changes in the renal secretory structures, it is often the case that diuretics fail to produce their appropriate effect. In many such conditions it is a question how far it is desirable to stimulate the diseased organ, and in the great majority of instances only the mildest diuretics should be prescribed. When renal inflammation is present, even if it be chronic, irritating diuretics should be avoided. In acute Bright's disease large draughts of water at regular intervals not infrequently have a very favorable effect; not only greatly increasing the amount of urine, but also lessening the irritation of the kidneys. In grave cases, with violent irritation of the kidneys and perhaps suppression of urine, hypodermatoclysis has proved of great benefit. (2) To get rid of fluid in various parts of the body. For this purpose diuretics, often combined, are employed in all forms of dropsy. (3) To diminish irritation of the genito-urinary organs, as from the deposit of solids from the urine. Here diuretics are of great service by diluting the secretion, and the value of water as an adjuvant to medicinal diuretics should always be taken advantage of. The alkalies are also of special utility.

In the use of diuretics it is important to have in mind that they may act in a variety of ways, and as it is not always possible to determine the precise cause of the deficiency in the urinary excretion, it is quite customary to prescribe two or more of these drugs in combination, in the hope that one of them at least may prove effective.

2. *Drugs Diminishing the Quantity of Urine Secreted.*—These are usually of such a character as to induce acute nephritis when given in large doses; *e. g.*, turpentine, cantharides, phosphorus. Methyl acetanilide also is reputed to diminish the quantity of urine. They are never given for this purpose in medicine.

3. *Drugs Rendering the Urine Acid.*—Hexamethylenamine is the most reliable remedy to render an alkaline urine acid. The benzoates are also used for this purpose, as benzoic acid during its passage through the kidney is converted into hippuric acid, and they may be given for alkaline decomposition in the urinary passages. The free use of carbonated water increases the acidity of the urine. Salicylic acid is capable of slightly increasing it, and also very large doses of citric and tartaric acids, borax, and possibly benzosulphinide.

4. *Drugs which Render the Urine Alkaline.*—Some **salts** of the **metals potassium, sodium, lithium** and **calcium** will do this, *e. g.*, the carbonates, borates and hydroxides; even the tartrates, citrates, malates, lactates, and acetates, since they are excreted by the kidney as carbonates. Nitric acid is said to increase the amount of ammonia in the urine, and thus to render it slightly alkaline. Ammonium salts given internally do not render the urine alkaline, because they are decomposed in the body, with the formation of urea; they may even increase the acidity from the larger amount of nitric acid excreted.

Antilithics are drugs which tend to prevent the decomposition, in the urinary passages, of the solids of the urine. When the secretion is acid, gravel or uric acid calculus is liable to occur from the crystallization of uric acid, or, more rarely, lime oxalate calculus, from the crystallization of lime oxalate. Whenever a tendency is shown to the formation of either of these calculi, alkalies or other remedies reputed to prevent this should be administered. For uric acid the following are chiefly used: distilled water, potassium salts, lithium salts, piperazine and lycetol. For lime oxalate, dilute nitro-hydrochloric acid, carbonated water, and lactic acid (for digestion). When, on the other hand, the urine undergoes alkaline decomposition, phosphatic calculi are liable to form from the crystallization of phosphates. Here the aim must be to render the secretion acid and aseptic, and benzoic acid, the benzoates, salicylic acid, the salicylates, as well as hexamethylenamine or other urinary antiseptics, are given for this purpose.

Lithontriptics are agents which are supposed to promote the solution of calculi, but as a matter of fact, no means has as yet been discovered which is capable of dissolving a calculus when once formed. It is true that alkalies have been credited, owing to their action in the test-tube, with the power to dissolve uric acid calculi; but in the body alkalies cannot convert free uric acid into soluble alkaline urates, but at most into acid urates, which are found to be almost as insoluble as uric acid itself. Hence, it is believed, it would be quite impossible to effect in this way the solution of even very small calculi.

Therapeutics.—The chief use of alkalies in this connection is to diminish or entirely neutralize acidity of the urine, and thus prevent as far as possible the precipitation of uric acid. In this way they tend to prevent increase in the size of a stone already formed. They are also of service in lessening the irritability of the urinary passages. In the case of gouty subjects they are prescribed not only to alkalize the blood, but also to alkalize the urine, since in such persons the deposition of uric acid in the urine is a common occurrence. The citrates and acetates are the best forms in which to give the alkalies, as they are not apt to interfere with the digestion, and potassium and lithium citrate and acetate are to be preferred, since these metals form more soluble urates than sodium. Copious draughts of water, by diluting the urine, aid in the prevention of calculi, and natural mineral waters, especially those containing lithium, are in very general use.

5. *Drugs Preventing the Urine from Decomposing.*—Urine retained from any cause in the bladder will undergo alkaline

decomposition, and the same result is likely to occur from the admixture of pus, as from cystitis or pyelitis, with the urine. This decomposition of the urine may be prevented by the administration of drugs which in their excretion by the urine render it aseptic. Such are—

(1) **Hexamethylenamine.**
(2) **Benzoic acid.**
(3) **Salicylic acid.**
(4) **Uva Ursi.**
(5) **Copaiba.**
(6) **Cubeb.**
(7) **Oil of Santal.**
(8) **Benzosulphinide.**
(9) **Boric acid.**
(10) **Many volatile oils.**

6. *Drugs Altering the Composition of the Urine.*—Almost any drug will do this, either because it is excreted in the urine, or because it sets up certain changes in the body the products of which are excreted in the urine; but it will be sufficient to refer to a few striking examples.

Turpentine, cantharides and salicylic acid in large doses will cause hæmaturia, for the reason that they set up inflammation of the kidney.

Potassium chlorate, all nitrites, acetanilide, pyrogallic acid, poisoning by the mushroom (*Helvella esculenta*), and transfusion of blood break up red blood-corpuscles, and the products when excreted by the urine render it dark. Large doses of mineral acids, arsenic, naphthol and naphthalene may occasionally produce the same result.

Phosphorus in large doses causes leucin and tyrosin to appear in the urine, while the urea is greatly increased.

The saline diuretics increase the solids of the urine.

The chrysophanic acid in rhubarb and senna makes the urine, if it is acid, a brownish color; if it is alkaline, a purplish red. Logwood renders alkaline urine reddish or violet. Santonin colors acid urine yellow or greenish-yellow, and alkaline urine, reddish. Phenol, naphthalene, creosote and other preparations of tar, as well as the arbutin in uva ursi, chimaphila and gaultheria make it dark greenish-brown. Picric acid makes it a bright yellow, and methyl violet a dark blue. The urine of persons poisoned with carbonic oxide remains sweet for months.

Poisoning by carbonic oxide, curare, amyl nitrite, and turpentine, and sometimes chloroform, camphor, mercury, morphine, hydrocyanic acid, sulphuric acid, alcohol, lead compounds, and salicylic acid, lead to the appearance in the urine of a body which, like sugar, reduces Fehling's copper solution. In the case of some of these drugs, at least, the urine does not contain glucose, but glycuronic acid; for although it reduces blue copper solutions, it does not undergo alcoholic fermentation on the addition of yeast or give the phenyl-hydrazin test. Hydrated chloral was formerly supposed to induce glycosuria, but this has been shown not to be the case, the reducing agent in the urine being urochloralic acid, and not sugar. The administration of phloridzin, a glucoside from the bark of stems and roots of the apple, pear, plum and cherry, which, when continuously heated with dilute mineral acids, is resolved into glucose and phloretin, leads to the production of genuine glucose in the urine.

Some drugs impart a peculiar odor to the urine; for instance, the smell of violets is produced by turpentine and oil of juniper. The aromatic odor of cubeb and copaiba can be detected in the urine after the administration of these substances.

Prolonged poisoning by lead often induces chronic nephritis. This is usually of the granular type, but in some instances the kidney presents a mixture of interstitial and parenchymatous disease. In acute mercurial poisoning, when death does not follow in the course of a few hours, anuria is not infrequently observed, and this has been found to be due to renal changes, the most prominent feature of which is necrosis of the epithelium of the tubules. Fatty degeneration of the renal epithelium may be caused by phosphorus and arsenic.

7. *Drugs Acting on the Bladder and Urethra.*—Practically, the only ones of value are **sedatives** to the urinary tract.

If the urine shows a tendency to decompose, the drugs which prevent decomposition, and if the urine is excessively acid, alkalies, act as urinary sedatives. Other sedatives are **opium, belladonna, hyoscyamus, pareira, buchu** and **uva ursi,** which are direct sedatives to the vesical and urethral mucous membrane.

Urinary sedatives are used very largely in cases of cystitis and urethritis, whatever the cause may be. Local astringent and antiseptic injections are also employed.

A. DIURETICS.

WATER.

1. **AQUA.**—Water.
2. **AQUA DESTILLATA.**—Distilled Water.

ACTION OF WATER.

External.—An *indifferent* bath (31.1° to 36.6° C.—88° to 98° F.), or one in which there is experienced a sensation of neither heat or cold, produces no particular effect.

In a healthy individual a *cold* bath causes at first a feeling of extreme chilliness, the teeth chatter, and the extremities are blue and covered with *cutis anserina.* This is because the blood is driven away from the surface, which is consequently left cold. The abstraction of heat lowers the bodily temperature, as the calorific centres are not able to produce all the heat required for the preservation of the normal temperature. Very shortly, however, reaction sets in; the extremities grow warm, the pulse grows stronger and more rapid, and the respiration, which was at first gasping, becomes full and regular. Every portion of the body now receives a more perfect supply of blood, and a general feeling of exhilaration is experienced, which, if the bath is left at this stage, often remains for many hours. This action is explained by the fact that cold always contracts the blood-vessels and reflexly stimulates the vital centres to increased activity. If the bath is unduly prolonged, the system suffers from the effects of over-stimulation, with more or less profound depression of the nervous system and circulation, and consequent interference with functional activity. The proper duration and temperature of the cold bath differs very greatly for different individuals. The daily use of a suitably regulated cold bath no doubt diminishes the liability to catch cold.

Warm baths cause flushing of the skin and have the effect of accelerating the pulse and respiration. They have a tendency to raise the temperature of the body by imparting heat to it and preventing loss of warmth from it. After the bath profuse perspiration results, while the excretion of urine is diminished. Owing to the dilatation of the cutaneous vessels caused by warm baths, the blood is withdrawn to a considerable extent from the internal organs, and in consequence of this their functional activity is lessened.

Water is not absorbed into the circulation through the skin in mammals. It has been ascertained that when it is absorbed into the red blood-corpuscles outside the body, some obscure change takes place in the latter, and the hæmoglobin diffuses into the surrounding fluid.

Internal.—Water if swallowed in sufficient quantities washes out the tissues and increases the flow of urine. Taken habitually thus, it somewhat augments the excretion of urea, while the amount of uric acid is said to be diminished. It has been supposed to have considerable effect in promoting tissue metamorphosis, through the increased movement of the lymph flushing out the cells and leading to a more complete removal of the waste products. It does indeed have some such action, but this is not as pronounced as is thought by many, as the increase in the nitrogen and sulphur eliminated in the urine has been found to amount to only 5 per cent., or less. Lukewarm water, as is well known, will cause nausea and vomiting, while hot water, in small amounts frequently repeated, is often very useful in controlling irritability of the stomach.

Therapeutics of Water.

External.—Cold baths are used for the subsequent exhilarating effects, which may be increased by brisk rubbing with a rough towel, but persons whose systems do not promptly react afterward should not resort to them. Cold salt baths, particularly if they are sea baths, are more stimulating than freshwater bathing. The use of a cold bath is popularly supposed to be dangerous to the over-heated, but persons with healthy circulations find nothing so refreshing and so preventive of muscular stiffness after severe exercise and sweating as a brief cold plunge- or shower-bath. **Cold baths** at the present time are very largely employed in the treatment of **febrile diseases**, more particularly **typhoid fever.** Vogel's statistics of typhoid at the Military Hospital in Munich, covering a period of fifty years, show a reduction of mortality from 20 per cent., under other methods, to 2.07 per cent. under what is known as the Brand (really Currie-Jürgensen) treatment. The latter consists in the use of water at about 21.1° C. (70° F.), for fifteen minutes every three or four hours, when the rectal temperature is at or above 39.4° C. (103° F.). In applying the method, the temperature of the bath is made at first about 29.4° C. (85° F.), and in each successive bath the temperature is lowered 2.8° C. (5° F.), until 18.3° C. (65° F.) is reached. Sometimes a bath is employed at a temperature 5.5° C. (10° F.) below that of the patient, and the water is then cooled by adding cold water or ice until it falls to a temperature of about 20° C. (68° F.). In these baths the patient is lowered into the tub by means of a sheet, and on being lifted back into bed is carefully dried, without rubbing, and left covered with a sheet or blanket. Brisk rubbing of the whole body should be carried out during the bath, and the feet kept warm. Cold baths are no longer used in the treatment of typhoid fever with the notion that they simply reduce temperature. They are useful for the stimulation of the nervous system which they effect to a greater or less degree, and for the marked diuresis which they produce, thus, supposedly, favoring the elimination of toxins by the urine. If for any reason the use of the cold bath is impracticable or unadvisable, various substitutes for this may be resorted to, such as sponging, affusion, or the cold pack. The latter consists of a sheet, four folds thick, wrung out in cold water and wrapped around the naked body for five or ten minutes at a time. Affusions were employed as long ago as 1795 by Currie, and in the form known as "slush baths" were used with excellent effect among troops in the Spanish-American war. Rubbing the surface with pieces of ice is also sometimes practiced. In pneumonia the cold bath is occasionally used, when the fever is high, but cold is more commonly applied by means of powdered ice, which, confined in rubber tissue, is placed in a flannel bag and bound to the chest over a layer of lint. Cold baths are also sometimes of service in entero-colitis and in acute rheumatism with high fever, and they undoubtedly constitute the best treatment for any sudden hyperpyrexia. Thus, ice-water baths are of the greatest possible service in sunstroke, or thermic fever, care being taken that friction of the skin is at the same time employed, in order to bring the hot blood to the surface and prevent congestions. Cold water may also be injected into the bowel in cases where the skin is cold but the central temperature very high. The application of ice-bags or of the cold water coil to various parts of the body is used for the purpose of controlling inflammatory action and sometimes also for the **hæmostatic** effect of the cold, as in pulmonary hæmorrhage, by its vaso-constricting action.

In nocturnal seminal emissions the submerging of the scrotum in a tumbler of cold water, or the dashing of cold water against the perineum, scrotum and lumbar region, is not infrequently beneficial. A very useful practice in dysentery is the gentle injection into the bowel of considerable quantities of cold water, and the use of a moderately forcible stream of water of varying temperature is highly esteemed by some physicians in the treatment of a number of affections of the rectum, anus, and genito-urinary apparatus. Among these may be mentioned hæmorrhoids, internal and external, prolapsus ani, slight cases of prolapsus recti, pruritus ani and vulvæ, eczema of the margin of the anus, vaginitis, varicocele, chronic prostatitis, and atonic impotence in the male. In these various troubles the application is made by means of a bidet, which, it is advised, should be attached to the water-closet seat habitually used by the patient. The bidet pipe should be movable by means of a handle, so that the stream can be directed wherever desired, and it should also have connection with the hot and cold water-supply of the house.

A cold bath is one the temperature of which is below 21° C. (70° F.), and a hot bath one with a temperature above 36.6° C. (98° F.). Anything between 31.1° and 36.6° C. (88° and 98° F.) is often spoken of as a warm bath, though it is really indifferent, and should more properly be called tepid. Hot baths, as they have the effect of liquefying the fatty secretions, are naturally more cleansing than cold. Like the application of heat in other forms, they **soothe pain,** and they are useful in alleviating muscular and mental fatigue and various inflammatory conditions. They also serve to **relieve muscular spasm,** as well as internal congestion, by withdrawing blood from the internal organs to the surface, and often prove of great value in colic, spasmodic stricture of the urethra, laryngeal spasm, infantile convulsions, etc. Hot baths and the hot pack are useful in renal disease and uræmia and in commencing colds, on account of the **free diaphoresis** which they induce; and after a hot bath the patient should be immediately wrapped in warm blankets and put to bed, in order to prevent contraction of the cutaneous blood-vessels and arrest of perspiration. A hot bath at bedtime is not infrequently of service in insomnia, and in many asylums for the insane it is customary to give a bath of the temperature of 40° C. (104° F.) as a remedy for this condition. The hot vapor, or Russian, bath is employed for many of the same purposes as the hot air, or Turkish, bath, and particularly when the skin or kidneys are inactive, but is not so generally useful, as no evaporation of perspiration can take place during the bath. A valuable method for using the hot vapor bath in a mild form is the "bronchitis tent," which consists of a bed canopy made by sheets, into which the steam arising from a steam sterilizer is introduced by means of a tube. While equally efficacious in the first stage of bronchitis in adults, it is more conveniently employed in the case of children on account of the size of the bed.

Localized hot baths act in the same way as general ones, but are less pronounced in their effects. A hot sitz bath causes dilatation of the vessels of the pelvic viscera and a hot foot bath of proper depth, dilatation of the branches of the femoral and probably of the iliac arteries. Mustard is often added to increase the effect, and both these forms are much used in amenorrhœa. The sitz bath is more particularly suited to spasmodic dysmenorrhœa, and the foot bath is commonly employed in the first stage of a cold. In gonorrhœa a hot sitz bath is a good prophylactic against chordee. In spasmodic croup benefit may be derived from the application to the neck of a hot compress made from several layers of flannel wrung out of water and covered with cotton and oiled silk. In various painful inflammatory affections of the eyes much relief may be derived from the use of hot water applied by cotton pledgets, frequently renewed, or allowed to drop continuously upon the eye from a fountain syringe. Irrigation with plain hot water, or with normal saline solution (*see* Sodium Chloride) has proved of great service in markedly lessening tenesmus in acute dysentery. Enteroclysis is now also employed with advantage in a variety of other conditions, among which may be mentioned shock, nephritis, especially acute uræmia, auto-infection from retention of putrid contents in the intestine, cholera infantum, toxæmia in fevers, particularly typhoid, septic endocarditis and septic con-

Action of Buchu.

In moderate doses buchu causes in the stomach a feeling of warmth, which is often diffused gradually over the body. In large doses it gives rise to nausea, vomiting, purging and strangury, with a burning sensation in the epigastric region. Buchu stimulates the appetite and digestion, and slightly increases the pulse-rate. Its volatile oil, which is diffused into the blood, is excreted by the kidneys, the bronchial mucous membrane, which it stimulates, and probably also by the skin, as it induces mild diaphoresis. The excretion is chiefly by the urine, which it renders slightly antiseptic, but, although it is generally regarded as a diuretic, it does not appear to appreciably increase the renal activity. Under its influence the urine becomes darker in color, assumes an aromatic odor, and deposits a brownish sediment. After its elimination by the kidneys it acts as a disinfectant to the urinary tract. The free use of buchu, if continued for a considerable period, is said to be injurious to the kidney.

Therapeutics of Buchu.

It has been used in atonic dyspepsia, certain cutaneous affections, dropsy, and chronic rheumatism. It is difficult to see how it could have any effect in the last of these conditions, and in dropsy also it probably does no good when given by itself. The infusion (1 to 20, dose 30 to 60 c.c.; 1 to 2 fl. oz.) contains very little of the volatile oil, but is an excellent vehicle for saline diuretics. The chief therapeutic use of buchu is in chronic affections of the mucous membrane of the genito-urinary tract, and it is a valuable remedy in pyelitis, lithiasis, cystitis, urethritis, and prostatitis. It is also occasionally prescribed as an expectorant in bronchitis. It is well to note that the fluidextract, on account of the oil in its composition, is not readily miscible with water.

UVA URSI.

UVA URSI.—Uva Ursi (Bearberry). **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Uvæ Ursi.—Fluidextract of Uva Ursi. **Dose, 2 c.c. (30 ♏).**

ACTION OF UVA URSI.

Uva ursi is a tonic, **astringent** and **diuretic**, and is also reputed to have some oxytocic action. In medicinal doses it promotes the appetite and has a somewhat constipating effect upon the bowels. Large doses ordinarily occasion vomiting and purging, but it is stated that these effects may be prevented by filtering the watery preparations through animal charcoal, or by administering the glucoside, arbutin, instead of the cruder preparations. This is decomposed by the action of acids or of emulsin into glucose and hydroquinone or methylhydroquinone, and in the body a part appears to undergo this decomposition. The larger portion of it, however, is found to be eliminated by the kidneys unchanged, and it has been suggested that the small amount of hydroquinone and methylhydroquinone which appears in the urine may perhaps be formed from arbutin by the bacteria of the intestine, and not by the activity of the tissues. The diuretic effect of uva ursi seems to be unquestionably due to the direct action of the drug upon the renal epithelium. It also has a decidedly **anti-putrefactive** effect upon the **urine**, which was formerly attributed to the formation of hydroquinone, but which is now believed to be due to the arbutin itself; which, in addition to exerting a moderate stimulant action on the kidney cells, appears to be somewhat antiseptic. Uva ursi is therefore a mild disinfectant to the urinary tract. Under its influence the urine often becomes dark in color, the discoloration becoming more marked when it is allowed to stand and undergo putrefaction, and this is due to the hydroquinone, which becomes further oxidized and forms brownish-green pigments similar to those observed after phenol and other agents of its class.

THERAPEUTICS OF UVA URSI.

Like buchu, it is used in pyelitis, cystitis, urethritis, etc. It often serves to relieve incontinence of urine, dysuria and strangury, and the fluidextract is an excellent remedy for the **ardor urinæ** of acute gonorrhœa. Arbutin (dose, .20 gm.; 3 gr.) has been successfully employed in gonorrhœa and also as a diuretic in cardiac dropsy. Uva ursi is said to have sometimes proved serviceable in uterine hæmorrhages.

SABAL.

SABAL.—Sabal. (Saw-palmetto.) **Dose, 1 gm. (15 gr.).**

Unofficial Preparation.

Fluidextractum Sabal.—Fluidextract of Sabal. **Dose, 1 c.c. (15 ♏).**

ACTION OF SABAL.

It is a diuretic, and also has expectorant and sedative properties. Under its use the digestion is improved and the strength and weight increased, and it likewise tends to induce sleep. Its volatile oil is excreted mainly by the mucous membranes, and on these its principal effects are exerted.

THERAPEUTICS OF SABAL.

In general, all catarrhal conditions are improved by sabal, especially when it is combined with oil of santal. It has been employed for irritated states of the mucous membrane of the nose, pharynx, larynx and bronchial tubes. It relieves cough of various kinds, and is of some service in chronic bronchitis, laryngeal phthisis, and cardiac asthma. It is also given in cystitis and to relieve the vesical distress of prostatic hypertrophy, and is thought to be more or less effective in functional impotence.

JUNIPER.

OLEUM JUNIPERI.—Oil of Juniper. **Dose, 0.2 c.c.; 3 ♏.**

Preparations.

1. **Spiritus Juniperi.**—Spirit of Juniper. **Dose, 2 c.c. (30 ♏).**
2. **Spiritus Juniperi Compositus.**—Compound Spirit of Juniper. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF OIL OF JUNIPER.

Oil of juniper is a stomachic tonic, antiseptic, diaphoretic, diuretic and aphrodisiac. Its action is practically the same as that of oil of turpentine, but it is less apt to interfere with the digestion or to cause hæmaturia and albuminuria. It is, however, a powerful **renal stimulant** and in large doses irritant; so that from sufficient amounts there may result strangury, priapism, hæmaturia, suppression of urine, and uræmic convulsions. It imparts a violaceous odor to the urine, and will produce diuresis when inhaled in an atomized solution.

THERAPEUTICS OF OIL OF JUNIPER.

It is a very efficient diuretic, and is largely used, combined with other less irritant diuretics, in the treatment of dropsies resulting from cirrhosis of the liver, organic heart disease, and chronic Bright's disease. As it is a constituent of gin, this, or the compound spirit of juniper, may be given to patients suffering from such affections who require an alcoholic stimulus. Oil of juniper may also be used in chronic pyelitis, cystitis, prostatorrhœa, gleet, etc., but it should never be prescribed when acute nephritis is present. Occasionally it is employed as a carminative and stomachic.

PAREIRA.

PAREIRA.—Pareira (Pareira Brava). **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Pareiræ.—Fluidextract of Pareira. **Dose, 2 c.c. (30 ♏).**

ACTION OF PAREIRA.

With the exception of its diuretic action, in which it closely resembles buchu, pareira is not known to have any physiological effects.

THERAPEUTICS OF PAREIRA.

Like buchu, it is employed in chronic pyelitis, vesical catarrh, gleet, and other chronic inflammatory affections of the genito-urinary tract. It was formerly renowned as a lithontriptic.

PICHI.

Fabiana.—Pichi (not official). **Dose, 2 gm.; 30 gr.**

Unofficial Preparation.

Fluidextractum Fabianæ.—Fluidextract of Fabiana. **Dose, .30 to 2.50 c.c.; 5 to 40 ♏.**

ACTION OF PICHI.

Pichi is a diuretic with properties similar to those of buchu and uva ursi.

THERAPEUTICS OF PICHI.

It is of great value in inflammation of the bladder and catarrh of the urinary tract. It should not be used in organic disease. It is best prescribed in combination with an alkali, as sodium carbonate.

THEOBROMINE.

Theobrominæ Sodio-salicylas.—Theobromine Sodio-salicylate (not official). (Diuretin.) **Dose, 1 to 2 gm.; 15 to 30 gr.**

ACTION OF THEOBROMINE SODIO-SALICYLATE.

This is a pure diuretic, acting upon the renal epithelium, without action upon the heart, and it is believed that it does not irritate the kidneys.

THERAPEUTICS OF THEOBROMINE SODIO-SALICYLATE.

It is best administered in solution with aromatic water. It has been given with benefit in cases of severe cardiac or hepatic dropsy. It does not ordinarily cause depression, but in occasional instances is said to have had an untoward action. This may, however, have been due to impurities.

APOCYNUM.

APOCYNUM.—Apocynum. (Canadian Hemp.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Apocyni.—Fluidextract of Apocynum. **Dose, 1 c.c. (15 ♏).**

ACTION OF APOCYNUM.

When used as an infusion (1 to 16), this is not only diuretic, but has an action resembling that of strophanthus and similar drugs. In large doses it is also a hydragogue cathartic.

THERAPEUTICS OF APOCYNUM.

This is a more valuable medicinal agent than its limited use would indicate. It frequently produces copious diuresis after other, and better known, drugs have failed, and the infusion, especially, has been found beneficial in dropsy.

CORN-SILK.

ZEA.—Zea. (Corn-silk.)

ACTION OF CORN-SILK.

Corn-silk is a mild but fairly certain diuretic when given in full doses. It increases the secretion of urine in consequence of the effect of its resinous acid in stimulating the renal epithelium.

THERAPEUTICS OF CORN-SILK.

It is useful in acute and chronic cystitis, in the bladder irritation of uric acid, and for phosphatic gravel. It is possibly, as well, a cardiac stimulant in the dropsy of heart disease. It is best administered in the form of an infusion, in boiling water (1 to 8), taken almost *ad libitum.*

PIPERAZINE.

Unofficial Preparations.

1. **Piperazinum.**—Piperazine. (Piperazidine. Dispermine.) **Dose, .50 to 1 gm.; 8 to 15 gr.**
2. **Lycetol.**—Lycetol. **Dose, .90 to 1.80 gm.; 15 to 30 gr.**

ACTION OF PIPERAZINE.

Piperazine is believed to increase slightly the amount of urea in the urine, while the uric acid coefficient is diminished. The testimony as to its diuretic action is conflicting, but the weight of clinical evidence is in favor of its being a reliable diuretic. In ordinary doses it does not appear to have any influence upon the nervous, circulatory or respiratory systems; nor does it irritate the gastro-intestinal or the genito-urinary tract.

THERAPEUTICS OF PIPERAZINE.

There is much clinical testimony as to the value of this drug in gout, goutiness (uricacidæmia) and rheumatism. It is here given, for considerable periods of time, in water containing carbon dioxide. It is so highly hygroscopic that it cannot be administered as pill or powder.

Lycetol, or dimethyl-piperazine tartrate, has been introduced for the purpose of combining the action of piperazine with the alkalizing and diuretic effects of a tartrate. It may be given in carbonated water or in the form of a lemonade.

CANTHARIDES.

CANTHARIS.—Cantharides. (Spanish, or Blister Beetles.) **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

Preparations.

1. **Ceratum Cantharidis.**—Cantharides Cerate.
2. **Collodium Cantharidatum.**—Cantharidal Collodion.
3. **Tinctura Cantharidis.**—Tincture of Cantharides. **Dose, 0.3 c.c. (5 ♏).**

ACTION OF CANTHARIDES.

External.—Cantharides is a **powerful irritant**, but the irritant action of this and other agents of its class still remains unexplained. It acts **more slowly** than **most irritants**, so that if a preparation of cantharides is applied to the skin, it will usually be two or three hours before any appreciable effect is produced. The first symptom from it is a tingling, burning pain in the part, which very shortly becomes reddened in consequence of the local vascular dilatation caused. In the course of three or four hours after the application numerous vesicles make their appearance, and these soon coalesce, forming one large blebs (varying in area according to the extent of the application), which is filled with clear serum. Although the local action is thus a **violent** one, it is also very **superficial.** Hence, as less of the irritant penetrates into the deeper tissues than in the case of the volatile oil of mustard, and the process is much slower, the **vesication** is much **less painful** than that caused by mustard. If the blister be broken, however, and the irritant be allowed to come in contact with the unprotected dermis, severe inflammation, with much pain, suppuration and even sloughing, is liable to result. Cantharides is an energetic **counter-irritant**, as well as a **rubefacient** and **vesicant**, and this action is probably due to an alteration in the calibre of the blood-vessels and in the sensory nerves, or their terminations, reflexly induced by it in the deep-seated organs in the vicinity of the part to which it is applied.

Internal.—*Gastro-intestinal Tract.*—When taken in sufficient quantity by the mouth, cantharides produces the same **irritant** effect along the alimentary canal, and gastro-enteritis results. If cantharidin is swallowed in solution, blisters are formed in the mouth and throat, and deglutition is rendered difficult or impossible by the excruciating pain and the swelling in the œsophagus caused by it. There is also intense pain in the abdomen, and vomiting ensues, followed by purging, with all the symptoms of shock and collapse. Both the matters vomited and the stools may contain blood. Ulceration of the stomach and other portions of the alimentary canal have been observed after death, not only when cantharides has been administered by the mouth, but also when the drug has been given by subcutaneous injection, and it is thought possible that under these circumstances it is excreted in part by the stomach, and that these lesions are produced in the act of excretion.

Genito-urinary Tract.—Cantharidin is absorbed from the alimentary canal and also to a less extent from the skin, and will exert its irritant action elsewhere, especially upon the organs of excretion. The effect upon the kidneys is seen in **diuresis,** and when a larger amount is absorbed, in nephritis, albuminuria, hæmaturia, glycosuria, and sometimes in total suppression of urine. The other parts of the urinary tract, the bladder and urethra, also show the action of the irritant, and **strangury,** with a constant desire for micturition, priapism, etc., is reflexly induced. The vesical tenesmus is extreme, and the patient suffers from severe pain in the loins. The local irritation is apt to occasion erotic excitement, with seminal emissions in the male, and there may also be swelling and inflammation of the external genitals. Sufficient of the active principle may be absorbed from a cantharides blister to cause marked renal irritation and strangury. The drug is chiefly excreted by the kidney, and the nephritis is the main factor in death from cantharidal poisoning.

Nervous System.—While cantharidin, thus absorbed, has no important action upon the internal organs other than those by which it is eliminated, when injected into the circulation of animals this agent is stated to affect the central nervous system in much the same way as phenol, producing short stimulation, excitement and increased reflexes, followed by paralytic symptoms, coma, etc. It is found, however, that this central action is not often observed, as it is mostly obscured by the gastro-enteritis or nephritis.

THERAPEUTICS OF CANTHARIDES.

External.—Cantharides is of all drugs the most commonly used as a **vesicant** and **counter-irritant.** Blisters may be made with cerate of cantharides spread upon linen. The raised cuticle should not be removed, but simply punctured to allow the escape of the serum, and the surface should then be dressed with some bland fat. A very convenient method of blistering is to paint the desired area with one or two coats of cantharidal collodion, and then lay over it a piece of waxed paper. In using a blistering plaster, sodium bicarbonate or a little morphine with powdered camphor may be sprinkled over its surface before it is applied, for the purpose of lessening the danger of strangury, and with the same end in view the preliminary use of an alkaline diuretic has been suggested. The tendency to strangury is also diminished by the free use of diluent drinks. Blisters are employed to relieve pain, reduce inflammation, and promote the removal of inflammatory products by absorption. They are thus of service in a great variety of conditions, although not in such general use as formerly, when heroic methods of treatment were more in vogue. Only a few of the special uses of blisters need be referred to here. They are applied over the chest in pleuritic effusions (a succession of small blisters being most efficacious), behind the ear in aural inflammations, on the perineum in obstinate gleet, around the affected joints in acute rheumatism, at the nape of the neck in severe headaches, and over the epigastrium for persistent pain in the stomach, vomiting, etc. They are of great value in neuralgia, especially if applied close to the emergence of the nerve from the spinal column, and also in sciatica and neuritis and in subacute joint affections. It has been shown by careful researches that a distinct relation exists between irritation of an internal organ and that part of the skin which is supplied by the same segment of the spinal cord or brain. While these superficial points are connected with the diseased organ only by means of nerve-fibres, it appears that a nervous impulse from these organs does not pass in an indeterminate manner through the central nervous system, but has a distinct tendency to affect the superficial areas which are supplied with sensory nerves from the same segment of the cord. It is therefore argued that an affection of these superficial areas may affect the corresponding internal organ more than the rest of the body, and that this satisfactorily explains the benefits derived from counter-irritants. In confirmation of this, attention is called to the fact that several of the points which were observed to be affected by internal disease are precisely those points at which experience has shown irritation to be of most service. Thus, the application of a blister to the epigastrium has long been recognized as a means of relieving stomach disorders, while the old treatment of iritis by means of a blister on the temple may be justified by the fact that in the researches mentioned an area of tenderness in this region was found to accompany the eye-disease. An aura proceeding from an extremity may sometimes be intercepted, and epileptic seizures averted, by encircling the limb with a strip of blistering-plaster. The moral impression produced by the use of vesication is not infrequently very beneficial. Hysterical paralysis is most successfully treated by encircling the affected extremity with narrow blisters, and hysterical aphonia may sometimes be quickly cured by a blister over the larynx. If in any case an especially pronounced counter-irritant effect is desired, the blister, after having been punctured, may be treated by the application of an irritating ointment. Unguentum Sabinæ (savin, 8; yellow wax, 3; benzoinated lard, 16) was formerly much used for this purpose. In blistering with cantharidal preparations the plaster should be removed as soon as the blebs has formed, on account of the danger of the absorption of cantharidin. When strangury is produced, relief may be afforded by an enema of laudanum or by a small hypodermatic injection of morphine. Among the conditions contra-indicating the use of blisters in general may be mentioned the acute stage of an inflam scurvy and purpura, pregnancy, infancy and debility. They should never be applied to a part on which a patient lies, on account of the risk of the formation of bed-sores, or to paralyzed limbs. Cantharidal blistering is contra-indicated in renal disease or inflammation of the urinary passages, and here vesication by ammonia water or chloroform (evaporation being prevented) may be substituted for it. These are rather more rapid in action, but much more painful than cantharides. By some it is advised that blisters should not be opened at all, but should be covered with antiseptic wool, by which means ulceration and inflammatory complications may be avoided. It is held also that the removal of the serum is practically equivalent to a blood-letting of the same amount, and that this is very rarely desirable. The cuticle raised by a blister may be used for skin-grafting.

Cantharides is one of the most common and useful remedies employed in the treatment of loss of hair. Good results may often be obtained from its use if the alopecia has not progressed too far, but it is hardly likely to prove of service if the treatment is begun late. It is usually applied in the form of tincture, largely diluted with alcohol, or as the active constituent of a pomade. Some such preparation as the following may also be employed to stimulate the growth of hair: Vinegar of cantharides (cantharides, 1; glacial acetic acid, 5; water), 1; glycerin, 1; spirit of rosemary, 1; water, 10. In alopecia circumscripta cantharidal collodion, painted over the bald patches every week or ten days, is occasionally successful.

Internal.—On account of its irritating properties cantharides is used internally to only a limited extent. It is given in the form of the tincture, in small doses, principally as a stimulant to the urinary organs, and among the conditions in which it has been commended are hæmaturia, incontinence of urine, chronic pyelitis, chronic cystitis, irritability of the bladder, gleet, prostatorrhœa, and spermatorrhœa due to deficient tone of the seminal vesicles. It is naturally contra-indicated when any active inflammation is present. Cantharides has some popular reputation as an emmenagogue, but if it has any influence at all upon the menstrual function, this is quite insignificant, and due, no doubt, only to its irritant effect upon the urinary organs and passages. It is one of the drugs most relied upon in the treatment of impotence, in which condition it may prove of service through reflex irritation from the urethral mucous membrane. Its administration is attended with considerable danger, however, since efficient doses are apt to induce nephritis. Several cases of poisoning have been reported from its use as an aphrodisiac, though it is stated that its aphrodisiac effect is usually more manifest under ordinary or even small medicinal doses than from immoderate amounts. Sometimes, but not often, it relieves chordee. Small doses are sometimes useful in the late stage of acute desquamative nephritis. It has been recommended for diabetes insipidus.

TOXICOLOGY.

Symptoms.—The effects of toxic doses of cantharides have already been described. In cases where lethal amounts have been taken, there usually result dyspnœa, great frequency of the pulse, and finally collapse and coma, death being sometimes preceded by convulsions. These fatal effects would appear to be dependent upon suppression of the urinary functions in consequence of the violent nephritis caused by the drug. It is one of the substances employed for the purpose of producing abortion with criminal intent, and it is in cases of this kind that symptoms of poisoning are most likely to be observed.

Post-Mortem.—There are found swelling and intense hyperæmia of the gastro-intestinal mucous membrane, with ecchymoses and often ulceration, and the appearances of acute inflammatory action also in the kidneys, bladder and whole genito-urinary tract.

Treatment.—There is no chemical or physiological antidote. The stomach should be emptied by emetics (*see* p. 159), or washed out by the stomach-pump. Mucilaginous and demulcent liquids should be freely given. Opium is indicated to relieve the pain and gastro-enteritis.

TRITICUM.

TRITICUM.—Triticum. (Couch-grass.) **Dose, 8 gm. (120 gr.).**

Preparation.

Fluidextractum Tritici.—Fluidextract of Triticum. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF TRITICUM.

Triticum is emollient and demulcent, and has some nutrient qualities. It has been regarded as a diuretic also, but the increase in the amount of urine noted under its use appears to be due simply to the water given with it.

THERAPEUTICS OF TRITICUM.

For its soothing and supposed diuretic properties it has been used in dysuria, irritability of the bladder, chronic cystitis, irritable prostate, gleet, and other affections of the genito-urinary tract. The infusion is a popular fever-drink in Europe.

B. DRUGS PREVENTING THE URINE FROM DECOMPOSING.

HEXAMETHYLENAMINE.

HEXAMETHYLENAMINA.—Hexamethylenamine. (Hexamethylene Tetramine. Urotropin). **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF HEXAMETHYLENAMINE.

Large doses in man (*e. g.* 10 gm.; 150 gr.) are well borne. Intravenous injections in rabbits and dogs do not increase, but, rather, slightly lower blood-pressure, while very large doses cause albuminuria in rabbits and hæmaturia in dogs. Of most importance is the inhibitory action of this remedy upon micro-organisms when it is split up into formaldehyde and ammonia, the former being the active agent. This takes place for the most part, after ingestion, in the urine, which is not only of the proper temperature for the purpose, but also contains uric acid and acid salts, which are efficient. Further, as has been shown, it will dissolve uric acid at the temperature of the body. Lastly, it may or may not produce diuresis.

THERAPEUTICS OF HEXAMETHYLENAMINE.

This remedy is of especial value in diseases of the urinary passages. In ammoniacal fermentation of the urine, which is extremely frequent in the cystitis of prostatic hypertrophy, the maximum dose given for two or three successive days is efficient in clearing that excretion. Inasmuch as the growth of the micro-organisms is inhibited, the remedy should be continued in sufficient amount to maintain this result. In gonorrhœal posterior urethritis, cystitis and pyelitis the results are equally favorable. It may be employed as a prophylactic measure before operations upon the genito-urinary tract. For the uric acid diathesis it has been used with good results by most, with failure by a very few, physicians. Since it is not always diuretic, other measures should be employed to increase kidney action. As a so-called lithontriptic some success has been claimed. For phosphaturia excellent results are reported. Inasmuch as the specific bacillus of the disease is found in a very considerable percentage of urines from patients suffering from typhoid fever, and failure to disinfect this excretion is a source of danger, urotropin should be administered not only for this purpose but also in order to avoid the cystitis which sometimes supervenes in the course of this disease.

BENZOIN.

BENZOINUM.—Benzoin. (Gum Benjamin.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Adeps Benzoinatus.**—Benzoinated Lard.
2. **Tinctura Benzoini.**—Tincture of Benzoin. **Dose, 1 c.c.; 15 ♏.**
3. **Tinctura Benzoini Composita.**—Compound Tincture of Benzoin. (Friar's Balsam.) **Dose, 2 c.c.; 30 ♏.**

ACIDUM BENZOICUM.—Benzoic Acid. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Liquor Antisepticus.—Antiseptic Solution. **Dose, 4 c.c. (1 fl. dr.).**

AMMONII BENZOAS.—Ammonium Benzoate. **Dose, 1 gm. (15 gr.).**

LITHII BENZOAS.—Lithium Benzoate. **Dose, 1 gm. (15 gr.).**

SODII BENZOAS.—Sodium Benzoate. **Dose, 1 gm. (15 gr.).**

Action of Benzoic Acid.

As benzoic acid, its salts, and benzoin all have practically the same action, that of benzoic acid only will be here described.

External.—Like salicylic acid, it is irritant to mucous membranes, and its vapors when inhaled are capable of exciting a catarrhal condition of the bronchial membrane. When applied in a concentrated form it is also irritant to the skin. In antiseptic power it appears to be equal, if not superior, to salicylic acid, preventing the growth of many forms of bacteria in a solution of 1 in 1000.

Internal.—In the body its action is in many respects very similar to that of salicylic acid, and, like the latter, it may be taken in comparatively large quantities without the production of toxic symptoms. In very large doses it sometimes causes nausea and vomiting, and in occasional instances the matters vomited may be tinged with blood. It produces a moderate acceleration of the pulse, and has some effect in increasing and disinfecting the bronchial secretion. It is therefore regarded as an **expectorant**, and it is thought probable that either the acid or one of its derivatives is excreted by the bronchial mucous membrane. It is said also to be excreted by the skin, and thus stimulate its functional activity, though this has been denied by some. It differs from salicylic acid in being less stimulant to the central nervous system, and in man a certain sedative effect has been observed under it. In dogs it may give rise to tremors and convulsions, and the following phenomena have also been observed: Ataxia and paresis, followed successively by complete paralysis of the anterior and posterior extremities and trunk; fall of temperature; death from asphyxia. The pulse and respiration are first accelerated and then slowed, from a direct action on the heart and on the respiratory centre. As the gastric mucous membrane has been found after death to be eroded and ecchymosed, even when the acid has been injected subcutaneously or intravenously, it is believed that benzoic acid has a specific action on this membrane quite apart from its irritant effects when applied locally. In the dog, as well as in man, vomiting is produced when the acid is given by the mouth in sufficient quantity. While traces of benzoic acid have been found in the saliva of dogs after the administration of the drug, it is thought that it is not excreted by the salivary glands in man. It no doubt lessens the putrefaction in the intestinal canal, as some diminution in the double sulphates and the indican of the urine has been observed after its administration by the mouth. Benzoic acid and the benzoates, particularly sodium benzoate, appear to have the effect of somewhat **stimulating** the functional activity of the **liver.**

An important feature of the action of benzoic acid is that it is in great part excreted in the urine as **hippuric acid,** which is formed in the body from a combination with glycocoll. Hippuric acid is benzoyl-glycocoll, so that a synthetic process takes place, benzoic acid combining with glycocoll, and hippuric acid and water being the result — $C_6H_5 \cdot COOH + H_2N \cdot CH_2 \cdot COOH = C_6H_5 \cdot CO \cdot HN \cdot CH_2 \cdot COOH + H_2O$. It has not as yet been determined from what source the nitrogen required for this is derived. Some of the benzoic acid escapes in the urine, and the proportion of hippuric acid formed appears to depend more or less upon the condition of the kidneys (in which the synthesis takes place) and of the general health, as well as upon the amount of benzoic acid ingested.

If hippuric acid is given by the mouth, it is stated that benzoic acid is found in the blood, but that hippuric acid reappears in the urine. When benzoic acid has been administered to the mother shortly before delivery, hippuric acid has been observed in the urine of the new-born infant. It is generally believed that the hippuric acid formed from benzoic acid in the system increases the acidity of the urine and **renders alkaline urine acid,** while it also tends to **disinfect** and stimulate the **genito-urinary tract.** Most clinicians agree that the acidity of the urine is increased after benzoic acid, and it is thought probable that the disappearance of uric acid crystals from the urine under its influence is due to the conversion of insoluble uric acid into soluble hippuric acid. It has been asserted by some, however, as the result of experiment, that sodium benzoate does not increase the acidity of the urine, and that the mistake of clinicians has arisen from the fact that in cystitis the urine has its acidity increased by the drug for the reason that the ammoniacal fermentation is checked by the benzoic acid. During its excretion by the kidney benzoic acid slightly stimulates the renal cells, and thus has a mild diuretic effect. After large doses there has sometimes been found in the urine a reducing body, which is presumed to be glycuronic acid. By some it is believed that this is always the result of intoxication, so that unless symptoms of poisoning are present, no such reducing action will be observed. Phthalic acid, and possibly succinic acid, may also occasionally appear in the urine after the administration of benzoic acid. Benzoic acid is found to increase to a considerable extent the nitrogen eliminated in the urine, and it would therefore seem, like salicylic acid, to augment the decomposition of the proteids in the body. The action of benzoic acid on the body-temperature is probably similar to that of salicylic acid. One of the rarer results of the administration of the drug is urticaria or an erythematous condition of the skin.

THERAPEUTICS OF BENZOIC ACID.

External.—On account of its marked antiseptic qualities, as well as its stimulating effect, the compound tincture of benzoin is quite largely used as a surgical dressing. It is applied on lint to wounds and ulcers, and when injected into sinuses it disinfects the tract and promotes healing. It makes a good application for spongy gums, and is also used to paint over abrasions and excoriations, as in the case of tender nipples. Its use in the same way is recommended in the treatment of chilblains, after the part has been washed with a 5 per cent. solution of phenol. It sometimes relieves the itching of urticaria or eczema, and, mixed with an equal quantity of glycerin, is serviceable for chapped lips and hands, chapped and fissured nipples, and frost-bite. A solution of tincture of benzoin in cologne-water is also often successful in urticaria, and a lotion made with the tincture, and containing mercuric chloride, may be applied for the removal of freckles or moth-spots and in pityriasis versicolor and chronic urticaria. In catarrhal affections of the pharynx and larynx the compound tincture, more or less diluted, makes an efficient application, and the hoarseness of singers and public speakers, the result of undue strain upon the vocal cords, is frequently relieved by this remedy. Benzoinated lard is a favorite basis for ointments the active ingredient of which it is desired to have absorbed, as the benzoin prevents the decomposition of the lard when melted on the skin. Where the benzoin causes irritation, as it may near the eye, a non-irritant basis which keeps indefinitely may be made by adding 3 parts of oil of cloves or 2 of oil of gaultheria to 480 parts of lard.

Internal.—Urinary Organs.—The chief value of the benzoic compounds is no doubt in diseases accompanied by disordered conditions of the urine. Ammonium and sodium benzoates are preferable to benzoic acid itself on account of their much greater solubility, and they may with advantage be combined with some such sedative as hyoscyamus. Spirit of chloroform is sometimes employed to cover the taste. In pyelitis or cystitis the alkalinity of an ammoniacal urine is promptly diminished, the hippuric acid which is formed combines with ammonia to form ammonium hippurate, less triple phosphate results in consequence, and the condition is therefore ameliorated. As the acidity of the urine is increased by the salts, they may also be of more or less service in phosphaturia and in vesical calculus. During the presence of fever the transformation of benzoic acid into hippuric acid is much diminished, and in advanced parenchymatous nephritis and amyloid disease of the kidney is entirely abolished, the benzoates being excreted as such. The latter fact goes to confirm the results obtained from experiments on dogs, showing that this change takes place only in the kidneys, and probably in the renal cells. In some animals, however, notably the rabbit and the frog, the kidney is not the only place of synthesis. In certain cases of chronic Bright's disease the benzoates may be used with advantage. They are also sometimes of value in chronic gonorrhœa, in obstinate irritation of the urethra due to the condition of the urine, and in incontinence caused by an alkaline urinary reaction.

Pulmonary Organs.—Benzoin and its derivatives, especially sodium benzoate, were at one time employed to a considerable extent in phthisis, but have now for the most part been abandoned, as it has been found that they have no such effect on the tubercle bacillus as had been hoped, though they may some-

THERAPEUTICS OF COPAIBA.

External.—Like terebinthinates, copaiba serves to stimulate, as well as protect, parts to which it is applied. It is sometimes used as a dressing for chilblains, frost-bites, sore nipples, anal and other fissures, etc. A mixture of equal parts of copaiba and rosin cerate has been recommended as an efficient application for indolent ulcers. It has also been used, on account of its stimulating and antiseptic effects, in chronic skin diseases, such as psoriasis, lupus and leprosy, and as a topical application to the urethra or vagina in chronic gonorrhœa.

Internal.—Occasionally copaiba is employed as an expectorant in bronchitis, especially where the secretion has become profuse and fetid. In chronic conditions it has the effect of diminishing, instead of increasing, secretion, and on this account as well as its disinfectant properties, it may serve a useful purpose. It was formerly given to a considerable extent in pyelitis, cystitis, vaginitis, and a variety of other affections, but at the present time its use is almost entirely restricted to the treatment of gonorrhœa and gleet. The reasons for this are its unpleasant taste, the offensive odor which the drug gives to the breath of those taking it, and its liability to cause disagreeable eructations, to derange the digestion, or to produce eruptions on the skin. In gonorrhœa it has proved so undeniably efficacious, however, that in spite of the objectionable features attendant upon its administration, it still holds its place as a standard remedy in this disease. It is regarded as safe to begin the use of copaiba in gonorrhœa as soon as the initial severity of the attack has subsided and the bowels have been freely opened. It is best administered in capsules, and may be combined with other agents if desired.

CUBEB.

CUBEBA.—Cubeb. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Cubebæ.**—Fluidextract of Cubeb. **Dose, 1 c.c. (15 ♏).**
2. **Oleoresina Cubebæ.**—Oleoresin of Cubeb. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

3. **Trochisci Cubebæ.**—Troches of Cubeb.

OLEUM CUBEBÆ.—Oil of Cubeb. **Dose, 0.5 c.c. (8 ♏).**

ACTION OF CUBEB.

External.—By reason of its volatile oil cubeb is irritant and rubefacient when applied by inunction.

Internal.—Its action is much the same as that of copaiba, though it is somewhat less irritant. In small doses it is an aromatic stomachic and carminative, and assists digestion. Large doses cause marked gastric and sometimes intestinal irritation, with nausea, vomiting, abdominal pain, and perhaps purging, while the urine may contain albumin or blood, or both. It is absorbed, and, like other volatile oils, produces some cardiac stimulation and also stimulates the functions of the organs by which it is eliminated. It is excreted by the kidneys and lungs, and perhaps by the skin, and its chief action is on the mucous membrane of the **genito-urinary tract.** This is not only powerfully **stimulated** but also **disinfected** by it, as the urine containing the drug acts as a stimulant and antiseptic lotion. It sometimes gives rise to a cutaneous **papular** or **erythematous eruption,** but whether this is due to its excretion by the skin, as believed by some, or to the gastric disturbance is as yet undetermined. As cubeb induces considerable irritation of the kidney, it is a **diuretic.** Containing, as it does, like copaiba, a resinous acid, this is considered to aid the effects of the oil in its action upon the renal epithelium, as well as upon the bronchial mucous membrane. This resin also is excreted in the urine and is precipitated by the addition of acids.

THERAPEUTICS OF CUBEB.

Cubeb is one of the drugs most commonly employed in the treatment of genito-urinary affections, especially gonorrhœa, gleet and chronic cystitis. It is considered most valuable in the acute stage of gonorrhœa. It often relieves functional irritability of the bladder, and sometimes checks nocturnal incontinence of urine. Some patients are peculiarly susceptible to its effects, and in them even small doses may produce gastric disturbance or vesical irritation, with bloody urine. In the treatment of affections of the respiratory passages it has a well-established position. Powdered cubeb, blown into the nostrils by an insufflator, is employed in chronic nasal catarrh, and is also sometimes an efficient local application in hay-asthma unaccompanied with fever and in follicular pharyngitis. The symptom asthma is often relieved by cubeb cigarettes, and these are useful also in sensitive hypertrophies of the nose and in mild bronchitis. The troches are employed by vocalists and public speakers, and many popular bronchial troches contain cubeb. It is of considerable service in subacute or chronic bronchitis, especially when there is a profuse muco-purulent secretion. It is not much used as a stomachic or cardiac stimulant, on account of its liability to cause digestive disturbance, but in atonic dyspepsia its carminative effect on the stomach may sometimes be availed of by its cautious employment in small doses. Cubeb is of decided service in cases of chronic catarrh of the colon and rectum, with a relaxed condition of the mucous membrane and of the inferior hæmorrhoidal vessels. In hæmorrhoids it is less efficient than black pepper.

OIL OF SANTAL.

OLEUM SANTALI.—Oil of Santal. (Oil of Sandal Wood.) **Dose, 0.5 c.c. (8 ♏).**

ACTION OF OIL OF SANTAL.

The action of the oil of santal closely resembles that of copaiba and cubeb, but it is less irritant, as well as more agreeable to take, than either of the others. Like them, it is a **bronchial** and **genito-urinary stimulant** and **disinfectant.** Its absorption and excretion are very rapid, and it appears in the urine in about half an hour after ingestion by the mouth. After daily doses of 4 c.c. (60 ♏) irritation of the alimentary canal and urethra, with an eruption of small red papules upon the skin and conjunctiva, have been observed.

THERAPEUTICS OF OIL OF SANTAL.

It is best administered in capsules, or in an emulsion, and is much used in gonorrhœa and gleet. One objection to it is its expense and on this account it is frequently adulterated. The advantage of pure oil of santal over copaiba and cubeb is that it does not nauseate or disturb digestion, and it can be given with good results during the inflammatory stages of gonorrhœa or cystitis. In addition to these affections, it is of service in pyelitis, urethral hæmorrhage, and bronchitis. Two or three drops on sugar will often be found to relieve the hacking cough with which there is little expectoration.

MATICO.

MATICO.—Matico. **Dose, 4 gm. (60 gr.).**

Preparation.

Fluidextractum Matico.—Fluidextract of Matico. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF MATICO.

Matico probably has much the same action as cubeb, influencing chiefly the genito-urinary passages.

THERAPEUTICS OF MATICO.

It has been given for the same cases as cubeb, but is now rarely used. The leaves are sometimes placed upon a bleeding surface. Their numerous hairs promote the clotting of the blood, and thus they are hæmostatic.

BENZOSULPHINIDE.

BENZOSULPHINIDUM.—Benzosulphinide. Saccharin. (Gluside.) **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

ACTION OF BENZOSULPHINIDE.

Saccharin is an antiseptic, but almost the only practical use which is made of it in this capacity is in the surgery of the bladder. Its principal use is as a sweetening agent. It is not a food, and is eliminated in the urine and saliva without change.

THERAPEUTICS OF BENZOSULPHINIDE.

It is quite generally employed as a substitute for sugar when from any cause, as in diabetes mellitus, this cannot be taken. It may be used in tablets (for sweetening a cup of tea or coffee one-quarter grain; 0.015 gm., is sufficient) or in the form of soluble saccharin, which is prepared by neutralizing a solution of sodium bicarbonate with saccharin. It contains about 90 per cent. of saccharin, and is soluble in 15 parts of water. An excellent elixir for covering the taste of nauseous medicines may be prepared as follows: Benzosulphinide, 2; sodium bicarbonate (90 per cent.), 1; alcohol, 5; water, 35 parts. Saccharin is used as an internal antiseptic in cystitis with ammoniacal urine, and has been highly commended as a mouth-wash in aphthæ and a topical agent in ozæna.

DIVISION VII.—DRUGS ACTING ON THE BODILY HEAT.

A. Antipyretics, or Drugs which decrease the Body Temperature.—With the exception of those which, when given in sufficient quantity to induce severe collapse may in this way cause the temperature to fall below normal, there are few drugs capable of reducing the temperature in health. The term antipyretic is therefore limited to such drugs as have the power of depressing the body temperature in fever. In health the temperature is maintained at a uniform point through a balance established between the production of heat (**thermogenesis**) and its dissipation (**thermolysis**) through the skin, lungs and other organs. The main source of production is the voluntary and involuntary contraction of the muscles, and the loss of heat occurs to some extent through the lungs, but chiefly by means of radiation from the cutaneous blood-vessels and the evaporation of perspiration. Now if an excessive formation of heat takes place, as during active muscular exertion, this is compensated for by an increased output from the skin, through the dilation of the vessels and by the perspiration. On the other hand, if there is an increased heat dissipation from exposure to cold, this is offset by an augmented combustion of the tissues, with the formation of more heat. In order to preserve a balance between the heat producing and heat dissipating agencies there must be present a coördinating mechanism, and there is considerable reason for locating this about the corpus striatum, in the basilar ganglia of the cerebrum. Lesions in this part of the brain are usually found to cause a very marked rise of temperature, and it is stated that in animals no shivering is produced by cold after section of the cerebral peduncles. The heat regulating function (**thermotaxis**) is more or less deranged by various poisons, and especially by such as are generated in fever. The existence of a heat-regulating centre in the brain, it may be stated, has never as yet been definitely proved, and some investigators believe that the vaso-motor centre in the medulla oblongata is sufficient to explain the normal coördination of formation and output. It has lately been suggested that the thyroid and suprarenal glands, one of which is thought to be perhaps the main organ of the body to provide vaso-dilating material, while the other furnishes the chief supply of vaso-constricting material, may play an important part, by their opposed action, in this alternate opening and shutting of the blood-vessels. As affording some support to this view, attention has been called to the fact that in the babe, which apparently has no heat governor or regulator, since its temperature varies with that of its surroundings, the thyroid is but imperfectly developed, while the suprarenal glands have been observed to contain no vaso-constricting material.

Antipyretics which increase the loss of heat.—Among these are included all sudorifics and dilators of the cutaneous blood-vessels. Cold, as in the form of a cold bath, acts by direct abstraction of caloric. The action of **salicylic acid** and **salicin** in reducing temperature is probably explained by the vascular dilation caused and the increase in the output of heat. This is also now believed to be the case with drugs of the class to which **acetanilide**, **antipyrine** and **acetphenetidin** belong. Some investigators, however, regard the fall in heat formation as too great to be explained in this way, and infer that these antipyretics diminish the combustion through some other action, though not by affecting the tissues directly.

Drugs which probably diminish the production of heat.—**Quinine** apparently does this by lessening the metabolism. The antipyretic action of digitalis may perhaps be due to its causing an increased activity of the heat-regulating centre, as has been shown to be the case with picrotoxin and several other central nervous stimulants. The fall of temperature produced by antimony has been explained by the slowness of the circulation and by the general depression and profuse perspiration. The precise manner in which aconite reduces the temperature is unknown. A cold bath not only abstracts heat, but if continued for a time diminishes its formation. Sometimes the removal of some reflex source of irritation may lower the temperature, and in this way purgatives occasionally act as antipyretics.

Therapeutics.—Alcohol, spirit of nitrous ether, antimony, ipecacuanha and opium were formerly in constant use as antipyretics, but at present are not very often given to reduce fever. Cold is more often employed, either by cold sponging, ice, or a cold bath. Sponging with hot water will, by the vascular dilatation and subsequent sweating it induces, reduce a febrile temperature.

Of the drugs which are now used for this purpose, acetanilide and antipyrine are dangerous because of the collapse they may bring about, while quinine and salicylic acid are rather uncertain, except in ague and rheumatic fever respectively. Antipyrine is a very prompt and certain antipyretic, and, notwithstanding its dangerousness, it and acetphenetidin are most in demand. Acetphenetidin is less powerful, but quite safe, as a rule. Antipyretics, however, should be rarely given, as in sufficient doses to reduce the temperature they may cause dangerous depression. Fever is only a surface indication of the essential pathological condition, systemic infection, and if the pyrexia is not excessive, no special action is called for. When this is the case the external use of cold is generally preferable, since in addition to its antipyretic effect, it is likely to furnish a needed stimulus to the nervous system and prove beneficial in other ways.

B. Drugs which cause a rise of Temperature.—Belladonna may have this effect. The cause is not definitely known, but it has been attributed to direct action on the heat centres in the brain. The temperature is generally increased by poisonous doses of cocaine, also it is thought probable, from some disorder of the cerebral heat-regulating centres. Picrotoxin, like other convulsive poisons, may cause a rise of temperature when given in poisonous amounts.

Tuberculin, various albumoses, and certain animal poisons, such as that of shell-fish, will cause a rise of temperature. Their mode of action is unknown.

ANTIPYRETICS.

ACETANILIDUM.—Acetanilide. (Phenylacetamide. Antifebrin.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

> **Pulvis Acetanilidi Compositus.**—Compound Acetanilide Powder. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ACTION OF ACETANILIDE.

External.—It is antiseptic, hæmostatic, and slightly sedative.

Internal.—*Blood.*—Upon the red corpuscles it has the effect of causing the formation of methæmoglobin, and, in larger amounts, a disintegration of the corpuscles. The movements of the leucocytes are also arrested by it. The formation of methæmoglobin has been found to be much more pronounced inside than outside the body. The actions on the blood are decidedly weaker than in the case of phenol and other similar agents, but they occasion a peculiar **cyanosis,** which is much more intense than that caused by the formation of the same amount of methæmoglobin by other poisons. It is often accompanied by dyspnœa and acceleration of the pulse, and lasts for periods ranging from a few hours to several days.

Heart and Vessels.—The heart is at first accelerated and afterwards slowed, and this is attributed to the direct action of the drug upon the cardiac muscle. When a considerable reduction in temperature is caused, this also contributes largely to the slowing of the organ. The increased rhythm of the heart leads to a slight rise in the blood-pressure, but this falls as the pulse becomes slower.

Respiration.—This is not usually affected by ordinary doses, but under poisonous amounts it progressively fails.

Kidneys.—Acetanilide has some diuretic property. Some observers consider it probable that in large doses it increases the excretion of uric acid, but others state that in health it has no effect on the excretion of this substance. After ordinary doses the urea and total nitrogen of the urine may be slightly augmented, and in large amounts it causes an increase in these of from 30 to 35 per cent., so that there is a large increase in the tissue waste. Acetanilide is rapidly absorbed and rapidly excreted by the kidneys. It undergoes a partial oxidation, but, except after very large doses, none of the original body appears in the urine. Some of it enters into combinations with sulphuric and glycuronic acids, and the oxidation products often give a smoky color to the urine, especially after it has been exposed to the air for some time. After large doses the color of the urine may also be darkened in consequence of the presence of methæmoglobin. After acetanilide, ferric chloride gives a reddish-brown tinge to the urine.

Skin.—Diaphoresis may be produced in consequence of the increased cutaneous circulation, and in fever profuse sweating not infrequently follows its use. Sometimes an erythematous rash is caused which usually resembles that of measles. Occasionally urticaria occurs, and more rarely eczema and bullæ, while in some instances an œdematous swelling is observed. Such skin affections, which are less frequently elicited by acetanilide than by antipyrine, may possibly be accompanied by some febrile reaction.

Temperature.—Acetanilide has little effect upon the normal temperature, though it may cause a slight elevation unless the amount administered is sufficient to produce pronounced symptoms of collapse. If the temperature is above normal, however, it has a marked **antipyretic** effect, often reducing it to below normal. It was at one time supposed that acetanilide and other drugs of its class diminished the heat production in consequence of lessening the metabolism, in the same way as quinine. It is now known, however, that such is not the case, and it is held that the seat of their action is the base of the cerebrum. As to the *modus operandi* of these antipyretics, it is believed that they effect the reduction of pyrexia through alterations produced in the heat-regulating mechanism which result in lowering the point at which the temperature is maintained. Consequently, a great increase in the dissipation of heat must take place in order to get rid of the warmth that has accumulated in the body, and this augmented output is attained by dilatation of the cutaneous blood-vessels. Their principal action practically, therefore, is by causing an increased heat loss through this vascular effect, by reason of which a large amount of blood is exposed to the cold air. It has been shown experimentally that the dilatation of the cutaneous vessels is sufficiently marked to be recorded by the plethysmograph in many instances, while in others flushing of the skin is observed. There is also a lessened heat production, but this is found to be much less important, and is now generally regarded as due to the fact that, at the lower temperature caused, metabolism goes on less actively. The decrease in metabolism is really, then, an effect, and not a cause, of the fall of temperature. The degree of antipyretic action produced by these drugs is thought to depend to a great extent on the functional activity present in the centres, as it is found that there is a difference in the susceptibility of different fevers to the action of such agents; high continuous fevers reacting least, and those of an intermittent type being most amenable. Acetanilide, and its group, therefore, possesses anti-periodic properties, and in malarial fever the greatest effect is always produced when the action falls in the period of the natural decline of temperature.

Nervous System.—The action on the central nervous system, aside from that on the heat-regulating centre, consists in stimulation followed by paralysis, and a narcotic, a convulsant, and a collapse effect, which pass insensibly into each other, have been described. Its narcotic action renders acetanilide a powerful analgesic, although the narcosis is not at all comparable to that of the true narcotics, since cerebral action may be induced by small doses which do not apparently influence the mental activity. As the influence of ordinary doses upon the nerve cells appears to be very slight, it has been suggested that the action may perhaps be confined to some special areas of the brain. The convulsions produced by large doses are stated to be intermittent in character and preceded by increased reflex irritability. In the frog the excitability of the spinal cord may lead to convulsions, but in mammals the origin of the convulsions is not clearly understood. In general, they appear to be referable to the cerebrum, but it is thought possible that in some cases they may not be due to the direct action of the poison on the brain, but are rather asphyxial in character and dependent upon the changes in the blood, circulation and respiration. In ordinary poisoning the peripheral nerves and nerve ends do not seem to be seriously involved, and in both frogs and mammals the final paralysis is considered to be undoubtedly central. The convulsive stage is followed by unconsciousness, collapse, and total paralysis. The pulse, at first accelerated, becomes slowed, and the respiration is dyspnœic and then diminished. The skin is cyanotic and covered with cold sweat, and sometimes there are vomiting and dilatation of the pupils. Symptoms of collapse are occasionally produced in susceptible persons by medicinal doses, and especially if these are large, though death has been known to occur after only .30 gm. (5 gr.) in one instance. In this, however, it is possible that the drug may have been impure. In the milder cases the skin is cool and the pulse rather small and rapid, and the condition soon passes off. In severe cases the skin is cold and covered with a clammy sweat, the heart is weak, irregular, and sometimes fluttering, and the body temperature may be subnormal. The weakness of the heart is the principal source of danger, and the total failure of the circulation seems to be the cause of death. These cases of collapse occur more frequently when a rapid fall of temperature has been produced than under other circumstances, but may be observed in persons who have had no fever. The collapse sometimes appearing after small doses in fever, it has been suggested, may be due, not to the drug, but to the reduction of the temperature. In such cases, it is claimed, there was a pre-existing collapse, which was masked by the hyperpyrexia, the effects of which are in certain ways antagonistic to those of collapse. When, therefore, the stimulus of the high temperature is removed, the hidden collapse becomes apparent. Notwithstanding its insolubility, acetanilide is said to have been absorbed from wounds in sufficient amount to produce toxic symptoms.

Untoward Action.—In addition to the collapse and to the cutaneous eruptions or the cyanosis which occasionally follow medicinal doses of acetanilide, may be mentioned certain other untoward effects: digestive disturbances, symptoms resembling cinchonism, and paroxysms of sneezing. Under prolonged use of the drug congestion of the liver, spleen and kidneys is said to occur.

THERAPEUTICS OF ACETANILIDE.

External.—Acetanilide has been used with advantage as a dusting powder for venereal ulcerations, in place of iodoform, and in the form of an ointment (1 to 24) for chronic ulcers, eczema, urticaria, erysipelas, and other affections associated with considerable irritation. It has also been employed as an antiseptic for wounds. Too large a surface, however, should not be dusted over.

Internal.—*Pyrexia.*—Acetanilide was originally introduced as a rival to antipyrine on account of its powerful antipyretic action in fever, and it is still used to some extent for the reduction of temperature. The opinion is gaining ground, however, that if the temperature is not very high no attempt should be made to reduce it, as there is then no danger from this source, and, moreover, the theory is still held by some that fever is a defensive measure taken by the organism against the causes of disease. The principal objection to the use of acetanilide and other similar drugs is the cardiac depression which they are liable to induce, and hence in exhausting diseases like the continued fevers they may prove distinctly dangerous. In order to obviate this caffeine should always be administered, as is suggested in the compound powder. By most physicians of the present day, therefore, it is deemed safer, as well as preferable in some other respects, to use cold baths or some of the modifications of the Currie-Jürgensen treatment (*see* p. 460) whenever the temperature reaches such a point that the hyperpyrexia is dangerous to life. If it is decided to use antipyretics, acetanilide will often produce a rapid reduction of temperature. The minimum is reached in about two hours, and the effect may continue for a considerable time. This action does not persist after the drug is excreted, however, and hence the administration must be a continuous one, although if it is given when the fever is just beginning to rise again, smaller doses are required than at first. Of the more usual antipyretics, acetanilide produces probably the strongest collapse effects, and it is found not to keep the temperature down quite so long as some other remedies of its class. As it has no direct action upon the intestinal tract, it may be administered by the rectum when this seems desirable.

Analgesic Action.—Acetanilide is frequently useful in relieving the pain of neuralgia, sciatica, dysmenorrhœa, locomotor ataxia, migraine, and various headaches. Like the other antipyretics, it is largely employed in the treatment of influenza.

Exalgine (methyl acetanilide), in maximum dose of .20 gm. (3 gr.), is an efficient unofficial analgesic for migraine, sciatica and other neuralgias, but larger amounts are dangerous.

TOXICOLOGY.

When symptoms of collapse are caused by acetanilide the treatment consists in stimulation, as in collapse from other causes. General stimulation is called for by alcohol and ether, given subcutaneously or by the mouth, or in both ways, and stimulation of the heart by the subcutaneous injection of strychnine. Oxygen inhalations may also be of service, and hot applications should be made to the extremities and body.

ANTIPYRINE.

ANTIPYRINA.—Antipyrine. (Phenazone. Phenyldimethylpyrazolon.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Unofficial Preparations.

Salipyrina.—Salipyrine. (Antipyrine Salicylate.) **Dose, 0.40 to 2 gm.; 6 to 30 gr.**

Pyramidonum.—Pyramidon. (Dimethyl - amido - antipyrine.) **Dose, 0.25 to 0.50 gm.; 4 to 8 gr.**

ACTION OF ANTIPYRINE.

Antipyrine in small doses may moderately increase arterial pressure by direct stimulation of the heart; in large doses it is a cardiac depressant, the final fall of blood-pressure being certainly due, at least in part, to a direct action upon the heart. It is mildly antiseptic, and will preserve blood for some days when added to it so as to form a 2 to 5 per cent. solution. It is also hæmostatic, having the property of coagulating proteids. Like acetanilide, it is somewhat diuretic, and it is excreted in great part unchanged in combination with sulphuric acid and perhaps with glycuronic acid. After antipyrine has been taken, the addition of ferric chloride to the urine gives a red color. It is a local anæsthetic, but irritation has followed its hypodermatic use. It may produce an erythematous or other rash. It rapidly reduces an elevated temperature in the same way as acetanilide. In large doses it is said to produce convulsions; later, coma and paralysis of motor nerves and muscles.

THERAPEUTICS OF ANTIPYRINE.

Antipyrine is given internally as a **powerful antipyretic**, in fevers of various kinds. It is also used as a hæmostatic in hæmorrhoids and epistaxis. It has been given with some success in diabetes. It is largely employed as an **anti-neuralgic**, relieving the pains of locomotor ataxia and other nervous affections, and as an **anti-rheumatic.** It has been highly recommended in chorea and epilepsy.

Salipyrine is prepared by the action of antipyrine upon salicylic acid in substance. It combines the therapeutic properties of these two substances. In chronic articular rheumatism and sciatica it may prove of service, but it does not prevent relapses. It has been successfully used for spasmodic dysmenorrhœa.

Pyramidon, dimethyl-amido-antipyrine, is a derivative of antipyrine by a substitution process. As compared with antipyrine, with which it has the same general action, it is less soluble and acts with less promptness, but its effects are more lasting, and the same results are said to be produced with about one-third the dose. As an antipyretic it has been highly praised in the fever of tuberculosis, in acute articular rheumatism, and in typhoid fever. It is claimed that when properly administered it has no deleterious effect upon the blood or the digestion, and that it exerts a beneficial rather than an unfavorable action upon the heart. As an analgesic and anti-neuralgic it has been given with considerable success in the pains of locomotor ataxia, in migraine, and in intercostal, trigeminal, and other neuralgias.

TOXICOLOGY.

While antipyrine is somewhat less liable to toxic action, it occasionally produces collapse effects in the same way as acetanilide. The treatment of the depression caused by it is the same as in the case of the latter. Antipyrine has been credited with a considerable number of deaths, but it is quite likely that most of them have been due to improper dosage.

ACETPHENETIDIN.

ACETPHENETIDINUM.—Acetphenetidin. (Phenacetin.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ACTION OF ACETPHENETIDIN.

Acetphenetidin has no action externally, nor on the gastro-intestinal tract, and with ordinary doses the blood is unaffected. It slightly depresses the heart, but does not in ordinary doses affect the respiration. It is a mild diuretic, and large doses cause the passage of altered blood. It is a **powerful antipyretic,** by increasing heat dissipation and also diminishing heat production to some extent. It is likewise a powerful **analgesic.**

THERAPEUTICS OF ACETPHENETIDIN.

It is a valuable remedy for **reducing fever,** and, because it depresses the heart but little, it is **safer** than either antipyrine or acetanilide. It is, however, very insoluble, and slower and less powerful than these remedies, though its effects last longer. Since it possesses a very marked analgesic action, acetphenetidin is to be preferred as a remedy for the relief of pain, as in neuralgia, sciatica, locomotor ataxia, migraine and various headaches. For this purpose, the dose of .30 gm. (5 gr.) should be administered every hour for three or four hours; when relief generally results. This drug has been of service in the treatment of epilepsy.

TOXICOLOGY.

Symptoms.—Acetphenetidin sometimes produces severe vomiting, sweating, feeble and rapid pulse, and collapse. *Treatment.*—Alcoholic stimulation. Strychnine hypodermatically. External warmth.

DIVISION VIII.—DRUGS ACTING ON THE RESPIRATION.

The influences affecting the respiration are so numerous and varied that it is not always easy to determine the precise mode of action of any drug which produces an impression upon it. Thus, the respiratory centre in the medulla (which is subject to direct or reflex influences from almost all the organs of the body), the movements of the respiratory muscles, or the circulatory mechanism influencing the respiration may be acted upon; or, again, alterations produced in the blood or in the air respired may affect the function. In therapeutics, however, the object is generally to remove the cause of or alleviate respiratory difficulty, rather than act upon the respiration itself. Drugs which produce changes in the blood and circulation have already been considered, while for the consideration of such modifications of the temperature, moisture and atmospheric pressure as are of service reference must be made to works on general therapeutics. Therefore, the respiratory drugs will now be treated of under the following heads:

A. Drugs altering the Composition of the Air inhaled.—In this come drugs which, when inhaled, have some direct effect on the respiratory mucous membrane, or the bronchial and pulmonary contents, and may also have remote effects. Certain drugs, although they are not employed for their effects on the respiration, are most conveniently administered by inhalation; *e. g.*, anæsthetics and amyl nitrite.

Some drugs when inhaled produce very marked irritation of the bronchial mucous membrane, thus giving rise to vascular dilatation and augmented secretion, and reflexly causing cough from stimulation of the sensory nerves of the part.

Such are iodine, bromine, chlorine, senega, ipecacuanha, sulphurous anhydride, nitric acid fumes, ammonia, and tobacco, as well as cold dry air. These are rarely used therapeutically as inhalations, and their inhalation is to be particularly avoided in irritable conditions of the bronchi.

The drugs which, when inhaled, are **soothing** to the bronchial mucous membrane, but are rarely employed, are—

Hydrocyanic acid. | **Conium.**

Inhalations which are used to **stimulate** the bronchi, that is to say, to increase their vascularity, secretion, and muscular power, are—

(1) **Phenol**
(2) **Oil of cajuput** } 1.20 c.c. (20 ♏).
(3) **Oil of pine,** 2 c.c. (30 ♏).

(4) **Compound tincture of benzoin,**
(5) **Creosote,**
(6) **Oil of cubeb.** } 15 c.c. (fl ℥ss).

The amounts given after each are the quantities that should be added to 500 c.c. (1 pint) of water at 60° C. (140° F.).

Inhalations which are used to **disinfect foul secretions** from the bronchial mucous membrane are those of—

(1) **Creosote.**
(2) **Iodoform.**
(3) **Mild solutions of benzoin.**
(4) **Phenol.**
(5) **Sulphurous anhydride.**
(6) **Oil of juniper.**
(7) **Oil of cubeb.**
(8) **Oil of eucalyptus.**

Inhalations for **relieving spasm** of the bronchial tubes are those of—

(1) **Conium.**
(2) **Stramonium.**
(3) **Chloroform.**
(4) **Ether.**
(5) **Amyl nitrite.**

B. Drugs acting on the Respiratory Centre.—If, when injected into the carotid artery, a drug produces a very prompt effect on respiration, it is concluded that it acts on the respiratory centre. In order to determine whether the drug acts on the centre, or on the vagal terminations in the lung, it is customary to divide the vagi and then observe whether it acts in the same way after, as before, the section.

Drugs which directly **stimulate** the respiratory centre are—

(1) **Strychnine.**
(2) **Ammonia** (very powerful).
(3) **Apomorphine.**
(4) **Belladonna.**
(5) **Stramonium.**
(6) **Hyoscyamus.**

Drugs which **depress** the respiratory centre are—

(1) **Physostigmine** (very powerful).
(2) **Hydrated chloral.**
(3) **Chloroform.**
(4) **Ether.**
(5) **Alcohol.**
(6) **Opium.**
(7) **Hydrocyanic acid.**
(8) **Codeine.**
(9) **Aconite.**
(10) **Veratrine.**
(11) **Conium.**
(12) **Caffeine.**
(13) **Quinine.**
(14) **Ipecacuanha.**
(15) **Antimony salts** (very weak).

Alcohol, ether, chloroform, caffeine, and quinine slightly excite, before they depress, the respiratory centre.

Therapeutics.—Drugs exciting the respiratory centre may be given, when there is any difficulty in respiration, for the purpose of increasing the force of the respiratory act; at the same time measures should be employed to remove the cause of the difficulty. They are, naturally, most frequently required in respiratory diseases, and especially bronchitis. Ammonia and apomorphine are very frequently prescribed for the reason that they are also powerful expectorants, and belladonna is applicable in cases with excessive bronchial secretion.

Drugs which depress the respiratory centre are very seldom required for this action; but the centre for the reflex act of coughing is in the immediate vicinity of the respiratory centre, and **opium, morphine, codeine, heroine, hydrocyanic acid, conium,** and **ipecacuanha** are often very valuable in allaying the continual hacking cough frequently accompanying disease of the heart and lungs.

The drugs which relieve cough are very numerous, since this may be reflexly set up by irritation of so many peripheral parts and internal organs, such as the nose, throat, pharynx, ear, teeth, larynx, trachea, bronchi, lungs, pleura, stomach, and liver; and consequently its successful treatment may depend upon the removal of local irritation in any of these.

C. Drugs affecting the Bronchial Secretion.

(*a*) *Those increasing it:*

(1) **Apomorphine.**
(2) **All alkalies,** especially **ammonium carbonate** and other **ammonium** salts.
(3) **Cocillaña.**
(4) **Ipecacuanha.**
(5) **Senega.**
(6) **Squill.**
(7) **Turpentine.**
(8) **Terebene.**
(9) **Camphor.**
(10) **Benzoin.**
(11) **Balsam of Peru.**
(12) **Balsam of Tolu.**
(13) **Antimony salts.**
(14) **Sulphur.**
(15) **Iodine.**
(16) **Pilocarpus.**
(17) **Many volatile oils.**

It is probable that volatile oils and substances containing them decrease the amount of bronchial secretion as a later effect.

(*b*) *Those decreasing it:*

(1) **Acids.**
(2) **Belladonna.**
(3) **Stramonium.**
(4) **Hyoscyamus.**

Many authorities believe that under some circumstances alkalies decrease the secretion.

(*c*) *Those disinfecting it:*—Drugs which, when inhaled, act in this way have already been mentioned. Copaiba, cubeb, eucalyptus, and many volatile oils are excreted partly by the bronchial mucous membrane, and thus will disinfect the secretion in this process.

Therapeutics.—In bronchitis, remedies which increase the secretion are used when the latter is so viscid that it adheres to the tubes and cannot be coughed up; and those which decrease it are employed when it is too watery to be easily expectorated. The use of the disinfectants is obvious.

D. Drugs relaxing Spasm of the Muscular Coat of the Bronchial Tubes, or Antispasmodics.—It is believed that the symptom asthma is due to a spasmodic contraction of the bronchial tubes, and as—

(1) **Stramonium**
(2) **Belladonna**
(3) **Hyoscyamus**
(4) **Grindelia**

relieve this symptom, it is concluded that these drugs relax spasm of the muscular coat of the bronchial tubes. Stramonium is the most powerful. From their analogous action in other parts of the body, it is probable that the following drugs act in the same way:

Chloroform, ether, opium, hydrated chloral, cannabis indica, amyl nitrite, and conium.

Therapeutics.—Stramonium is of great use for relief of the symptom asthma, and this and the other drugs may be employed for cases of bronchitis in which spasm of the tubes seems to result from the inflammation present. Many of these muscular depressants in all probability depress the nerves at the same time.

E. Drugs acting on the Vessels of the Bronchi.—These are the same as have been already described (p. 296) as acting on the vascular system generally.

F. Expectorants.—On account of the complexity of the modes of action of drugs affecting the respiratory system, it is customary to regard most of them, clinically, simply as drugs which hinder or aid the expectoration of the contents of the bronchial tubes. Those which aid it are divided into two groups, named after their action, not on the lungs, but on the circulation.

1. *Stimulating expectorants.*—These are stimulants to the circulation generally. They are—

(1) **Acids.**
(2) **Ammonium salts.**
(3) **Cocillaña.**
(4) **Senega.**
(5) **Squill.**
(6) **Benzoin.**
(7) **Benzoic acid.**
(8) **Balsam of Tolu.**
(9) **Balsam of Peru.**
(10) **Turpentine** preparations.
(11) **Terebene.**
(12) **Oil of pine.**
(13) **Nux Vomica.**
(14) **Sulphur.**
(15) **Quillaja.**

2. *Depressing expectorants.*—These depress the general circulation. They are—

(1) **Alkalies.**
(2) **Antimony salts.**
(3) **Ipecacuanha.**
(4) **Lobelia.**
(5) **Pilocarpus.**
(6) **Apomorphine.**
(7) **Potassium iodide.**

Therapeutics.—It is almost impossible to lay down any general directions. In any case before us we must consider the acuteness or the reverse of the disease and whether we wish to stimulate or to depress the circulation, to increase, to diminish or to disinfect the expectoration, to stimulate the respiratory centre, to overcome spasm of the bronchial tubes, or to allay a hacking cough; and then employ such remedy or combination of remedies as seems best to meet the indications present. Warmth to the chest and warm drinks are sedative, and increase the amount of secretion, while cold and cold drinks have an opposite effect.

G. Drugs which in Man sometimes produce Cheyne-Stokes Breathing.—These are morphine, potassium bromide, and hydrated chloral. In animals the following, in addition, may do it: picrotoxin, muscarine, digitalin, strychnine and ammonium carbonate.

B. DRUGS ACTING ON THE RESPIRATORY CENTRE.

HYDROCYANIC ACID.

POTASSII FERROCYANIDUM.—Potassium Ferrocyanide. (Yellow Prussiate of Potash.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

POTASSII CYANIDUM.—Potassium Cyanide. **Dose, 0.010 gm. = 10 milligm. (1/5 gr.).**

Preparation.

Acidum Hydrocyanicum Dilutum.—Diluted Hydrocyanic Acid. (Prussic Acid.) **Dose, 0.1 c.c. (1½ ♏).**

ACTION OF POTASSIUM CYANIDE AND DILUTED HYDROCYANIC ACID.

External.—Hydrocyanic acid is an active protoplasmic poison, and is toxic to all forms of life. It inhibits fermentation and putrefaction, and retards the growth of plants and the movement of animal cells. The diluted acid, when applied to the unbroken skin, is at first slightly irritating, but, as it penetrates the epidermis, it soon causes paralysis of the sensory nerve-endings, and thus has a **sedative** and **anæsthetic** effect. From abraded surfaces it is very rapidly absorbed, and toxic effects may result from this absorption. Potassium cyanide may possibly give the same results. It also produces a dermatitis on local application to the epidermis.

Internal. *Alimentary Tract.*—Hydrocyanic acid is quickly, and potassium cyanide less rapidly, absorbed by mucous membranes, and on the fauces, œsophagus and stomach the same sedative and anæsthetic effects are produced as upon the skin.

Blood.—Under the influence of hydrocyanic acid the tissues are unable to absorb the oxygen brought to them by the blood cells; in consequence, the oxyhæmoglobin of the blood is not reduced in the capillaries, and the venous blood, therefore, has the same bright red color as the arterial. Lactic acid and sugar, which are always present when the oxidation of the tissues is imperfect, are found in the blood in unusually large quantities during the action of hydrocyanic acid. In the body the acid does not enter into any combination with the hæmoglobin of the red corpuscles. Blood to which it has been added retains its red color much longer than ordinary blood, and it is thought by some observers that the reason for this is that the acid destroys some oxidizing substance or ferment in the blood. Whenever hydrocyanic acid and methæmoglobin come in contact, a combination is formed (cyanomethæmoglobin) which is distingushed from ordinary methæmoglobin by having a bright red color; and in cases of cyanide poisoning the dependent parts of the body are often found to present such a tinge in consequence of this action on the methæmoglobin which they contain after death. The blackness of the blood which is observed in the internal organs is believed to be simply the result of the rapid death, such as is met with after any sudden death in well-nourished persons; the tissues being still alive after the stoppage of the circulation, and using up all the oxygen contained in the blood.

Heart and Circulation.—The circulation is altered mainly through the action on the central nervous system, but the drug also acts directly on the heart. The pulse is apt to be slowed from the primary stimulation of the inhibitory centres, while the increased activity of the vaso-constrictor centres occasions a very considerable **rise** in **blood-pressure.** This central stimulation is succeeded by **paralysis,** in consequence of which the

blood-pressure falls very low, but the movements of the heart generally remain slow, notwithstanding the cessation of the inhibitory stimulation, since the cardiac muscle is now directly affected by the depressing action of the drug. It is found that if very large quantities are injected intravenously or inhaled, the heart may cease contracting for a few seconds, and then recommence a slow and feeble beat, which is quickly arrested again. This is thought to be due to primary action on the inhibitory centre, followed by direct paralysis of the heart.

Respiration.—The respiratory changes are caused by primary stimulation and subsequent paralysis of the medullary centre. After very large quantities the respiration may cease within a few seconds. Under the use of smaller doses it is rendered quicker and deeper at first. It then becomes irregular, subsequently grows very slow and deep, and finally ceases.

Nervous System and Muscles.—The central nervous system is primarily stimulated and then depressed and **paralyzed**, and the medulla oblongata and lower portions of the brain are at first much more profoundly affected than the cerebral cortex, although the final paralysis apparently includes all parts of the central axis. When the drug is given in doses small enough to permit of watching its action, it is found that this commences in the medulla, where the vaso-motor, respiratory, vagus, vomiting and pupil-dilator centres are all stimulated. Then unconsciousness results, and after this convulsions, which in man are believed to be chiefly medullary in origin. Finally, paralysis of the whole central nervous system ensues, and involuntary evacuations of fæces, urine and semen are frequently observed. During the convulsions, which are rare in man but common in animals, there is generally a temporary rise in blood-pressure, and the respiration is naturally very irregular. Death is due to arrest of the respiratory function, the heart continuing to beat for a short time. The phenomena of the action of hydrocyanic acid on the central nervous system, it will be seen, are very much like those of asphyxia, and it is regarded as probable that the latter plays an important part in their production, though the rapidity of their development indicates that they cannot be attributed entirely to asphyxia. The peripheral nerves and muscles, when suspended in an atmosphere of hydrocyanic acid, are weakened and eventually paralyzed; but in the living animal, unless large amounts of the drug are injected, are found to be not much affected.

Excretion.—Hydrocyanic acid is rapidly decomposed in the body. Part of it combines with sulphur-containing molecules to form sulphocyanides, and is excreted as such in the urine, while part undergoes further changes which are as yet unknown.

THERAPEUTICS OF POTASSIUM CYANIDE AND DILUTED HYDROCYANIC ACID.

External.—Hydrocyanic acid is a valuable antipruritic. The official preparation should always be well diluted, and lotions of a strength of about 1 to 48 may be applied to allay itching from almost any cause. They should not be employed in any case where the skin is broken.

Internal.—Hydrocyanic acid may be administered as the official diluted acid, oil of bitter almond (3 to 14 per cent. of acid), bitter almond water, cherry laurel water, the fluidextract, infusion and syrup of wild cherry, and as potassium cyanide. Reference should be made to each of these. In small doses the diluted acid, on account of its sedative and anæsthetic effect, is often useful in relieving vomiting or gastric pain, and in many instances it may be administered most acceptably in an effervescing draught. Since the effect of the remedy is transient, it should be given at frequent intervals. Enteralgia also not infrequently yields promptly to hydrocyanic acid. It is sometimes employed with advantage to allay cerebral irritation and excitement. The giddiness of Ménière's disease (auditory nerve vertigo) is sometimes benefited by it, and it may prove useful in relieving the nervous palpitation met with in some cases of organic disease of the heart, and also attacks of palpitation occurring as a symptom of a nervous condition in patients not affected with cardiac disease. It has been given in whooping-cough, and is very serviceable for the nervous cough of mothers which is not uncommonly observed in those whose children are suffering from this disease. It is used to a considerable extent as an ingredient of cough mixtures, on account of its effect in diminishing reflex excitability by reason of its depressing action on the central nervous system, and is especially valuable where there is a dry, hacking cough, without expectoration. Inhalations of a solution containing 1 part of diluted hydrocyanic acid to 1280 parts of water, at a temperature of 48.8° C. (120° F.), are sometimes given with benefit in asthma and the irritative cough of phthisis. The uses of potassium cyanide are similar to those of hydrocyanic acid.

TOXICOLOGY.

The great danger from hydrocyanic acid is the rapidity of its action, for the lethal dose of the pure acid in man (probably about .06 to .09 gm. (1 to 1½ gr.)) is much larger than that of some of the poisonous alkaloids. After large doses in mammals there may be practically no symptoms. The animal falls to the ground with a slight convulsive movement or a scream, and death results in a few seconds from arrest of the respiration and heart. One drop of the pure acid, however, when placed inside the eye of even moderately large animals, has been known to destroy life instantly. In man the symptoms usually commence in a few seconds after taking a large dose of hydrocyanic acid. The patient falls insensible, and the eyes will be found fixed, glassy, and with dilated pupils, the limbs relaxed, the skin cold and clammy, the pulse so small as to be scarcely perceptible, and the respiration slow, deep, and convulsive. Death takes place, as has been mentioned, from respiratory failure. When the poisonous quantity taken is smaller, there is at first an acrid, burning taste, which is accompanied by increased salivary secretion and followed by numbness of the mouth and throat. In the stomach there is a feeling of warmth, followed by nausea and vomiting. Other symptoms are headache, confusion, dyspnœa, slowness of the pulse, and great prostration, while the pupils are widely dilated and the eyeballs protrude. Soon unconsciousness supervenes, with or without convulsions, and then general paralysis, with involuntary defecation and micturition.

Post-mortem.—The characteristic odor of hydrocyanic acid is generally perceptible. The body is livid and the blood very dark. The heart is soft and flaccid and there is generally considerable congestion of the gastric mucous membrane. Post-mortem rigidity sets in very early, and the teeth are clinched, the fingers tightly closed, the toes strongly flexed, and the eyes prominent and staring.

Treatment.—In cases of poisoning by hydrocyanic acid the fatal result is usually produced so rapidly that the physician rarely has the opportunity of interfering. If life is not already extinct, the utmost promptitude is called for. The stomach should be washed out immediately, or vomiting should be induced by inserting the finger into the throat. Should this prove ineffectual, large doses of emetics must be given, as every moment is precious, and it is found that recovery is rapid when it has once set in. Atropine has been proposed as an antidote, but there is no reason to suppose that it will prove of service, since it has been shown that it is of no benefit in experiments on animals. The real element of danger is the stoppage of the heart, for although the respiration fails before this, respiratory paralysis can always be more or less successfully counteracted by artificial respiration, which is usually called for in poisoning by this drug. General stimulants, such as brandy or ether, given subcutaneously, are indicated, and ammonia, by inhalation, and caffeine may also be of service. Cold affusions, or alternately hot and cold, may be of assistance. Cobalt chloride, which has proved valuable in a considerable number of instances, is believed by some to be the best chemical antagonist. A thirty per cent. solution of hydrogen dioxide may be employed to wash out the stomach. Intravenous injections of sodium thiosulphate (producing theoretically the relatively harmless sulphocyanide) enable animals to survive an otherwise lethal dose. The following results of experiments recently made in Australia are of great interest and value: 1 to 100,000 of potassium cyanide produced in rabbits, within seven minutes, staggering gait and very rapid respirations, followed shortly by labored breathing. Convulsions of varying intensity always occurred, and at times appeared within three minutes after introduction of the drug. Exhaustion followed the spasms, respiration became shallower and shallower, and the animals died. Hydrogen dioxide, when used subcutaneously, as recommended, in 3 per cent. solution was immediately broken up, and its effects were *nil*. A similar result followed its administration by the stomach, even when the poison and the supposed antidote were introduced mixed. While hydrogen dioxide does oxidize cyanides, its action was found to be too slow to be of therapeutic value. Twenty-six experiments with cobalt chloride pointed to the fact that this salt is capable of forming an insoluble cyanide, but that for this purpose it must be given in excess. The acid of the gastric juice does not interfere with the reaction. Cobalt chloride itself, however, is not free from poisonous action, producing severe gastro-enteric symptoms. These should be carefully guarded against. Ferrous hydrate, when added to a cyanide salt forms a ferrocyanide almost instantaneously. This is but slightly poisonous, and its administration would seem to be even better than the cobalt, in view of the toxic action of the latter. Unfortunately, however, the strongly acid contents of the stomach contents greatly hinder the action of the ferrous hydrate, and hence alkalies must be added to neutralize the free hydrochloric acid. Magnesium oxide is the best for this purpose. Another drawback is that the ferrocyanides are kept in solution with difficulty. As the result of their investigations the experimenters recommend the following treatment: Have in readiness in places where cases of cyanide poisoning are likely to occur the following: 30 c.c. (1 fl. oz.) of a 23 per cent. solution of ferrous sulphate; 30 c.c. (1 fl. oz.) of a 5 per cent. solution of caustic potash; 1.80 gm. (30 gr.) of powdered magnesium oxide; a metal receptacle of 500 c.c. (1 pint) capacity; a stomach-tube. The first two solutions should be kept in air-tight tubes, which can be broken into the receptacle. When a case of poisoning occurs this is to be done, the powdered magnesia and 250 c.c. (½ pint) of water added, and the mixture shaken up and administered. This amount of antidote, it is stated, will take care of 6.50 gm. (75 gr.) of potassium cyanide. As cyanide poisoning has become not infrequent among the Australian miners since the introduction of the cyanides in the extraction of gold, it is advised that the antidote be kept in all mines where such processes are employed, in readiness for instant use, since time is the most important factor in securing a successful result.

WILD CHERRY.

PRUNUS VIRGINIANA.—Wild Cherry. **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Fluidextractum Pruni Virginianæ.**—Fluidextract of Wild Cherry. **Dose, 2 c.c. (30 ♏).**
2. **Infusum Pruni Virginianæ.**—Infusion of Wild Cherry. **Dose, 60 c.c. (2 fl. oz.).**
3. **Syrupus Pruni Virginianæ.**—Syrup of Wild Cherry. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF WILD CHERRY.

Wild cherry is an aromatic bitter tonic. As hydrocyanic acid is yielded when it is treated with water, its preparations possess more or less of the **sedative** action of that agent, and very large doses have a depressing influence upon the heart. In common with the apple and some other fruit trees, the root-bark contains a glucoside, *phloridzin,* which has the effect of producing glycosuria. This differs from the glycosuria met with in the disease diabetes mellitus in that the sugar of the blood is not augmented. Hence, it has been pointed out, it is not attributable to any change in the general metabolism, but no doubt to some alteration of the renal epithelium, in consequence of which the blood sugar escapes into the urine, instead of being retained in the system and used as a source of energy.

THERAPEUTICS OF WILD CHERRY.

It is highly esteemed as a stomachic tonic, and the infusion is used in atonic dyspepsia and chronic gastric catarrh, as well as in convalescence from acute diseases and other debilitated states of the system. The preparations of wild cherry have the same effect as hydrocyanic acid in relieving cough, by diminishing reflex excitability. The drug is sometimes a useful palliative in phthisis, where it may serve not only to alleviate the irritative cough, but also as a remedy for cardiac palpitation and gastric debility. The syrup is very largely employed as an ingredient of cough mixtures in general. Used as a vehicle for tincture of digitalis, it renders the latter less likely to produce gastric disturbance.

Aqua Laurocerasi (Cherry Laurel Water, not official) is standardized so that its strength is 0.1 per cent. of absolute hydrocyanic acid (dose, 2 to 8 c.c.; ½ to 2 fl. dr.). Owing to evaporation, it is of very varying strength, and as it cannot therefore be depended upon, and the inequality of its effects may possibly lead to disastrous results, it is but rarely employed, except it may be merely as a flavoring agent.

C. DRUGS AFFECTING THE BRONCHIAL SECRETION.

APOMORPHINE.

APOMORPHINÆ HYDROCHLORIDUM.—Apomorphine Hydrochloride. **Dose** (expectorant), **0.002 gm. = 2 milligm.** (**$\frac{1}{30}$ gr.**); (emetic), **0.006 gm. = 6 milligm.** (**$\frac{1}{10}$ gr.**).

ACTION OF APOMORPHINE HYDROCHLORIDE.

External.—Apomorphine is said to have some anæsthetic effects on the cornea when a solution is dropped upon it.

Internal. *Gastro-intestinal Tract.* — Apomorphine is the **most powerful emetic** known. It is an indirect emetic, because its action is on the vomiting centre in the medulla, and not a local one on the stomach. This is apparent from the fact that vomiting is produced more promptly, and with a smaller dose, if the drug is administered hypodermatically than when it is given by the mouth. It is shown even more positively by the fact that when injected subcutaneously it acts if the blood-vessels are ligatured in such a way that none of it can reach the stomach, while it does not act if they are so tied that none can reach the medulla. Moreover, no emesis is produced if apomorphine is placed in the stomach after the vessels supplying that organ have been ligatured. Still again, if the medulla be brushed with apomorphine solution, vomiting follows immediately. The act of vomiting is preceded by nausea, and it is found that symptoms of nausea may be elicited by doses of the drug too small to give rise to vomiting. Under the ordinary hypodermatic dose the latter usually occurs in man inside of fifteen minutes. The nausea generally disappears rapidly, but occasionally persists for some time, and may be accompanied by a repetition of the vomiting. Collapse has been known to occur, but this is simply a result of the vomiting and not a direct effect, and it is not usually dangerous. In frogs no emesis is induced by apomorphine.

Muscles.—Under large amounts the irritability of striped muscle is much diminished and finally abolished in frogs, but no such action has been observed in mammals. This weakening in the contraction of the muscles is quite distinct from the feeling of weakness accompanying nausea in man. In frogs a similar action has been demonstrated on the cardiac muscle; the heart being stopped even after atropine.

Heart and Circulation.—During the act of vomiting there is an increase of pulse and of blood-pressure. The acceleration of the pulse, however, as well as the feeling of depression and muscular weakness present, is simply a result of the emetic action. Although in a few instances alarming collapse has been observed, no actual fatality is stated to have occurred from the use of the drug.

Respiration.—There is an increase of respiration in consequence of the vomiting. If the amount of the drug is sufficiently large, its irritant effects are produced upon the rest of the central nervous system, as well as the vomiting centre, and in consequence of this action also the respiration is quickened. Physiological experiments show that apomorphine produces a watery discharge from the blood-vessels of the respiratory mucous membrane, which is found to be paler after the administration of this remedy, as well as less œdematous. This effect is produced within a half hour after ingestion, and it is not in any respect a phenomenon of the first stages of emesis. Large doses eventually depress the respiration.

Nervous System.—Its action on the central nervous system is shown first and mainly upon the **vomiting centre,** so that the only direct effect of small doses is the production of the symptoms of emesis. If the drug is administered in large quantities, and especially to animals incapable of vomiting, like the herbivora, its irritant effects upon the rest of the central nervous system are seen in the production of marked restlessness, with circus movements, excitement and terror. The movements then become less coördinated, and eventually tetanic convulsions set in. During the convulsions the respiration, which was at first greatly accelerated, ceases, while the heart continues to beat for some time later. In man minute doses are said to be slightly hypnotic.

Fate in the Body.—Apomorphine is not excreted into the stomach, like morphine, and it is stated that it has not been found in the mucous membranes of the air passages. It is possible that it may be decomposed in the tissues.

THERAPEUTICS OF APOMORPHINE HYDROCHLORIDE.

Vomiting Action.—The advantages of apomorphine over other emetics are that it is certain, prompt and energetic, that it can be given when emetics exhibited by the stomach would not act, and that it produces no gastric irritation. It is hence particularly valuable, administered subcutaneously, in cases of poisoning.

Expectorant Action.—It is, when given by the mouth, a valuable expectorant. In an adult, .002 gm. ($\frac{1}{32}$ gr.) will produce a watery expectoration within the time above stated, and this effect will last from two to three hours. It is especially useful in the early stages of acute bronchitis, in chronic dry bronchitis, in chronic catarrhal pneumonia, and in old tuberculous patients who are harassed by an unproductive cough.

Soporific Action.—Recently it has been claimed that when given hypodermatically at bedtime, in dose just short of producing emesis, sleep, closely approaching the normal, ensues. This is not always the case, and its hypnotic action may be due to contamination with other alkaloids.

COCILLAÑA.

Cocillaña.—Cocillaña (unofficial).

Unofficial Preparation.

Fluidextractum Cocillañæ.—Fluidextract of Cocillaña. **Dose, .30 to 1.20 c.c.; 5 to 20 ♏.**

ACTION OF COCILLAÑA.

Cocillaña acts upon muciparous glands, increasing their activity; on the bronchial mucous membrane, causing expectoration; on the intestinal mucous membrane, producing a laxative effect; it also slightly increases the appetite; it slightly strengthens the heart beat and the pulse, but does not stimulate the respiratory centre.

THERAPEUTICS OF COCILLAÑA.

Cocillaña is of very great value as an expectorant, preferable to ipecacuanha, in that it does not so readily cause nausea, while it assists the regular movement of the bowels. If, however, nausea should be produced, this is very persistent. Its action is fully established in from three to six hours after administration, and persists at least for six hours. It can, in many cases, be substituted for apomorphine, ammonium carbonate, and many other drugs, classed, with more or less reason, as expectorants.

IPECACUANHA.

IPECACUANHA.—Ipecac. **Dose** (expectorant), **0.065 gm. = 65 milligm. (1 gr.)**; (emetic), **1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Ipecacuanhæ.**—Fluidextract of Ipecac. **Dose** (emetic), **1 c.c. (15 ♏)**; (expectorant), **0.05 c.c. (1 ♏).**

2. **Pilulæ Laxativæ Compositæ.**—Compound Laxative Pills. **Dose, 2 pills.**

3. **Pulvis Ipecacuanhæ et Opii.**—Powder of Ipecac and Opium. (Dover's Powder.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

4. **Syrupus Ipecacuanhæ.**—Syrup of Ipecac. **Dose** (expectorant), **1 c.c. (15 ♏)**; (emetic), **15 c.c. (4 fl. dr.).**

5. **Tinctura Ipecacuanhæ et Opii.**—Tincture of Ipecac and Opium. **Dose, 0.5 c.c. (8 ♏).**

6. **Vinum Ipecacuanhæ.**—Wine of Ipecac. **Dose, 1 c.c. (15 ♏).**

ACTION OF IPECACUANHA.

External.—Ipecacuanha powder is a powerful **irritant** to the skin, producing redness, vesication, and even pustulation and ulceration, when its application is prolonged. It is also irritant, naturally, to mucous membranes, and some individuals are so susceptible to its local action that the opening of a jar of the drug at a distance of several feet will produce violent sneezing, irritation of the eyes, coughing, and other unpleasant symptoms. It possesses some antiseptic properties, being capable of destroying the bacilli of anthrax, though having no offect on the spores.

Internal. *Alimentary Canal.*—When taken by the mouth its irritant effect is exerted on the mucous membrane of the alimentary canal, and in **small doses** it is a **stomachic**; producing moderate gastric hyperæmia and an increased flow of saliva and gastric juice, and thus aiding digestion. In **large doses** it is a powerful **emetic.** It is still an unsettled question whether this action is due entirely to the local effect of the emetine on the stomach, or in part to this and partly to its influence on the vomiting centre in the medulla. Most of the evidence at command, however, points to a peripheral gastric, and not to a central, action. Unlike apomorphine, which is known to act directly on the centre, ipecacuanha causes vomiting as quickly and with as small doses when it is given by the mouth as when administered hypodermatically; and the fact that emetine, like many other irritants, has a specific action on the alimentary canal when injected subcutaneously would seem to satisfactorily explain the emetic action of the drug when given by this method. A certain amount of depression is produced by ipecac, but this is simply a result of the vomiting. If the dose is sufficiently large, and the most of it is not ejected in the emesis caused, the irritant effect of the drug is continued in the intestine, with the production of increased secretion and purging. It also has a **cholagogue** action, directly augmenting the biliary secretion. When injected subcutaneously in animals, emetine induces nausea, vomiting and catharsis, frequently with bloody stools, followed by collapse and generally by death from exhaustion in the course of a few hours. When vomiting is not produced by large doses given in this manner, collapse still results, and after some weak convulsive movements, the animal dies of cardiac failure. When the fatal result does not occur for from eighteen to twenty-four hours, evidences of gastro-enteritis are often found after death.

Circulation and Nervous System.—When emetine is injected intravenously the cardiac effects are more pronounced than when it is given by the mouth or hypodermatically. After large amounts the central nervous system is acted upon. Paralytic symptoms are developed, and among the earliest in mammals is **vaso-motor paralysis** with **fall of blood-pressure.** Contributory to the production of the fall is weakening of the heart's action from the direct effect of the drug upon the cardiac muscle, and this results in death. In the frog, in which no vomiting is caused, a slowly advancing central paralysis is observed, while the heart's movements grow weak and irregular, and finally cease from paralysis of the cardiac muscle.

Respiration.—The respiratory movements are but little affected by moderate doses of ipecac, though as the result of the vomiting they may be somewhat quickened. The inhalation of the powder causes congestion of the **bronchial mucous membrane,** with **increased secretion,** and excites cough by reflex stimulation; and the same effect is produced by the excretion by this membrane of the drug when it is taken internally. Animals poisoned by large doses of emetine present after death more or less hyperæmia of the bronchial mucous membrane and of the lungs, and in some instances, especially among rabbits, pulmonary œdema is found.

Skin.—Ipecac is in part excreted by the skin, and it acts as a **mild diaphoretic.** The cutaneous action resembles that produced by the application of warmth.

THERAPEUTICS OF IPECACUANHA.

External.—Ipecacuanha has been used with success, as an antiseptic, in cases of anthrax. In the dermatitis caused by rhus toxicodendron a lotion containing powdered ipecac, 1 to 40 of water, has been recommended, and for the bites of insects, especially mosquitoes, one composed of 2 parts of ipecac and 15 parts, each, of alcohol and ether.

Internal. *Alimentary Tract.*—Ipecac is quite generally employed as an emetic. It is contra-indicated in the very feeble, as it has no property that will serve to mitigate the depressing effects of the vomiting; nor, on account of the slowness of its action, should it be used in cases where, as in poisoning, a prompt evacuation of the stomach is called for. Its chief use as an emetic is for clearing the passages in diseases of the respiratory organs, and in infants and young children, particularly, who cannot cough well, it often acts very happily. In the domestic treatment of laryngismus stridulus an emetic dose of the syrup is the most usual remedy. Ipecacuanha is also of service as an emetic when the stomach is to be relieved of undigested food, and attacks of acute indigestion, migraine, and the so-called bilious headache may sometimes be cut short by the vomiting caused by it. An ipecac emetic was formerly administered to a considerable extent at the beginning of continued fevers, the eruptive fevers, erysipelas, and malarial fever, and some clinicians still advocate this method of treatment in suitable cases, claiming that experience has shown the good effects of the practice on the subsequent course of the disease. The indications for its use in cases of this kind are considered by them to be: a heavily coated tongue, much nausea with ineffectual efforts to vomit, marked epigastric oppression, icterus or an icterode hue of the surface, a hot and dry skin, acid and turbid urine. For emetic purposes a small dose (.03 gm. to ½ gr.) of tartar emetic is sometimes combined with it. In small doses, such as .25 to .30 c.c. (4 or 5 ♏) of the wine or .015 gm. (¼ gr.) of the powder, ipecac is sometimes used as a stomachic, and, employed in this way, it may even serve to check vomiting. It has been known to arrest obstinate attacks of vomiting which had resisted all other treatment, and one of the recognized methods of controlling the vomiting of pregnancy is the administration of .12 c.c. (2 ♏) of the wine in water every half hour. Ipecacuanha, .03 gm. (½ gr.), or more, combined with other cholagogues, has been found useful in cases of dyspepsia in which there is functional derangement of the liver, and in gastric ulcer Dover's powder (*see* p. 517) is sometimes beneficial. One of the most important applications of the drug is in the treatment of dysentery. Epidemic dysentery, especially of malarious and tropical countries, is the form of the disease to which it seems best adapted, but it may often be used with advantage in other varieties also. In the severe attacks of tropical regions from 1.20 to 4.00 gm. (20 to 60 gr.) are usually given for the initial dose, and about 1.20 gm. (20 gr.) every four, six or eight hours afterward. It is considered important to establish tolerance of the remedy as soon as possible, and subsequent doses may be retained if the first one is rejected. In order to secure the retention of these large doses it may be combined with opium and aromatic powder, or other expedients may be resorted to. Milk is a good vehicle for the administration of ipecacuanha, and in acute dysentery doses of 1 gm. (15 gr.), given in milk, are generally fairly well borne. Some authorities advise doses of 2 gm. (30 gr.), without any liquid, at the onset, the ipecac to be preceded by a sedative dose of opium. The good effects of the remedy have been attributed by some to the large amount of tannic acid contained in the root, and as emetine and cephaëline are much more irritant to the intestine than the unaltered drug, a preparation from which these alkaloids have been removed (Ipecacuanha Deëmetinisata, dose .60 to 2.00 gm.; 10 to 30 gr.) has been used with advantage, it is claimed, in this disease. On the other hand, it has been stated that the efficient agent in the treatment of dysentery is the emetine, and those holding this view deny that the same results are obtained by the use of this preparation. The deëmetinized ipecac is said to have the advantage of not causing any nausea or vomiting, and if the claims of its advocates should prove to be well founded, it would undoubtedly be much preferable on this account. In chronic dysentery ipecac is by no means so distinctly efficient as in acute, but in association with other remedies is often very useful. In catarrhal jaundice and in diarrhœa, especially when associated with hepatic derangement, it is sometimes of service. In bowel affections it is often combined with opium and mercury. It is useful also in the summer complaint of infants and young children when the stools are of a greenish color and contain mucus or blood. With it may be associated bismuth, pepsin, zinc oxide or other remedies, as indicated.

Respiratory Tract.—It is in very general use as an expectorant in the form of the syrup or the wine. It not only increases the secretion of the bronchial mucous membrane, but also has the effect of rendering it more fluid and therefore less tenacious; while its property of exciting the act of coughing often adds to its usefulness. The fluidextract is considered the most efficient preparation by some practitioners. The wine, more or less diluted, in the form of a spray from a hand atomizer, has sometimes been found of service in winter cough, chronic bronchitis, emphysema and fibroid phthisis, in allaying the spasmodic vomiting and liquefying the secretions. In children, too, the wine, in doses of from .30 to .60 c.c. (5 to 10 ♏), is apt to be especially beneficial in the chronic bronchitis which remains after whooping-cough, measles or influenza, or is associated with chronic tonsillo-pharyngitis or adenoids. A general tonic treatment should also be maintained at the same time. In the treatment of acute bronchitis ipecac is usually much more valuable in children than in the case of adults. Cephaëline seems to possess the [illegible] properties of ipecacuanha.

As a Diaphoretic.—Dover's powder is an excellent anodyne diaphoretic, and is frequently given, in doses of .60 gm. (10 gr.) in chills and in the early stage of catarrh of the respiratory passages and of mild feverish attacks in general. In the intense suffering which sometimes results from the sudden suppression of menstruation it is often of great service in relieving pain and promoting diaphoresis. In acute rheumatism and other diseases where also it is desired to allay pain, and at the same time increase the action of the skin, this powder may be administered in doses of from .18 to .30 gm. (3 to 5 gr.) every two, three or four hours, according to circumstances.

As a Hæmostatic.—Ipecacuanha has long been regarded as an internal hæmostatic, and it has been employed especially in hæmoptysis, hæmatemesis and uterine hæmorrhage. At the present time, however, it is much less frequently used as an anti-hæmorrhagic remedy than formerly. In hæmoptysis small doses, short of producing vomiting, it is stated, serve to reduce the bleeding by decreasing the pulmonary congestion. Some writers, on the other hand, advise that in hæmorrhages the drug should be given in frequently repeated doses until vomiting ensues, maintaining that when this effect is produced the hæmorrhage usually ceases. On account of their irritant properties, neither the preparations of ipecac nor its alkaloids are suitable for subcutaneous injection.

SENEGA.

SENEGA.—Senega. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Senegæ.**—Fluidextract of Senega. **Dose, 1 c.c. (15 ♏).**
2. **Syrupus Senegæ.**—Syrup of Senega. **Dose, 4 c.c. (1 fl. dr.).**
3. **Syrupus Scillæ Compositus.**—Compound Syrup of Squill. **Dose, 2 c.c. (30 ♏).**

ACTION OF SENEGA.

External.—Senega is **irritant** to the skin when applied repeatedly or rubbed on in the form of ointment, and has a very marked irritant action on mucous membranes. When the powdered root is inhaled it causes hyperæmia and increased secretion in the respiratory passages, and excites violent sneezing and coughing.

Internal. *Alimentary Canal.*—When swallowed, its irritant effect on the mucous membrane induces increased secretion of saliva and gastric juice. In large doses it causes not only salivation, but more or less marked inflammation of the gastro-intestinal tract, with nausea, vomiting and purging.

Respiration.—Senega is a **stimulating expectorant.** When the drug is taken internally, senegin is excreted through the bronchial mucous membrane, with the result of producing vascular dilatation and augmented secretion and of reflexly exciting cough. It is on the respiratory passages that it appears to exert its most important influence.

Blood and Circulation.—When added to defibrinated blood, senegin is found to dissolve the red corpuscles and liberate the hæmoglobin and the salts. Even when it is injected into the blood of living animals this action is observed to some extent, the plasma containing hæmoglobin, while the corpuscles are considerably diminished in number. In mammals the circulation appears to be comparatively little affected until shortly before death, when there is a rapid fall of blood-pressure and the pulse becomes feeble and slow. For a short time after the respiration fails the heart continues to beat, but its movements are extremely weak, and it finally **stops in diastole,** even if artificial respiration is maintained.

Nervous System and Muscles.—When senegin is injected into the blood in moderate toxic quantities, the symptoms usually produced are principally intestinal, and fatal collapse from the changes in the alimentary canal occurs after the elapse of several days; but when large doses are used the central nervous system is most affected. At first there are violent convulsions, then paralysis, especially of the respiratory centre, and the fatal result is very rapid. If the poison is applied directly to skeletal or cardiac muscle or to nerve trunks, they lose their irritability at once, and even in dilute solutions muscle contracts more weakly, and eventually is not only paralyzed but structurally altered.

Kidneys.—Senegin is absorbed with difficulty, and is excreted by the kidney, as well as the bronchial mucous membrane, and also to some extent, it is said, by the skin. In the process of excretion it irritates the renal epithelium, and the drug therefore has diuretic properties.

THERAPEUTICS OF SENEGA.

Senega is used now only as a stimulating expectorant. In subacute and chronic bronchitis it may prove useful in exciting an increased secretion of mucus and facilitating its expulsion from the respiratory passages. It should not be given in acute conditions on account of its irritant effect on mucous membranes, and for the same reason it is contra-indicated whenever gastric irritability or intestinal disorder is present. It is commonly prescribed in combination with other drugs in expectorant mixtures.

QUILLAJA.

QUILLAJA.—Quillaja. (Panama Bark. Soap Bark.)

Preparations.

Fluidextractum Quillajæ.—Fluidextract of Quillaja. **Dose,** 0.2 c.c. (3 ♏).

Tinctura Quillajæ.—Tincture of Quillaja.

ACTION OF QUILLAJA.

Quillaja is allied to senega in its properties, but is a much more powerful irritant, as the principle quillaja-sapotoxin is stated to be about ten times more poisonous than senegin.

THERAPEUTICS OF QUILLAJA.

On account of its soapy nature, it may be used to aid the diffusion of oils and other soluble bodies, but the fact that it contains such a toxic substance as saponin renders it objectionable for emulsifying medicines for internal use. It is employed chiefly as an ingredient of hair lotions, and hairdressers, for shampooing, use an aqueous decoction (1 to 20), which makes an excellent lather. In chronic eczema and alopecia circumscripta the tincture, used locally, may prove of service, and for certain forms of acne the fluidextract, mixed with glycerin, has been recommended. The tincture has been given occasionally as an expectorant, and it is stated to have proved efficient, especially in cases requiring the free expectoration of mucus which was accumulating in the chest. On account of its irritant qualities, however, it should always be employed with caution.

TEREBENE.

TEREBENUM.—Terebene. **Dose, 0.5 c.c. (8 ♏).**

Action of Terebene.

Its odor is more pleasant, but in other respects it for the most part closely resembles oil of turpentine. Like turpentine and many other volatile oils, it causes irritation of the lungs in the course of excretion, and therefore increases the bronchial secretion. It is likewise diuretic from the irritation of the kidneys excited in the process of excretion, and by its antiseptic properties it disinfects both the renal and bronchial secretions.

Therapeutics of Terebene.

Externally it has been used successfully as a general antiseptic dressing for wounds, ulcers, burns, etc. It has also been employed with advantage as a substitute for copaiba and other similar drugs in the treatment of genito-urinary diseases. In fermentative dyspepsia it is useful as an antiseptic. Its most important use is as a stimulating disinfectant expectorant, and it is highly esteemed in chronic bronchitis, emphysema, winter cough, and even phthisis. Although it is said to form an insoluble compound with sugar, it seems to be efficient when given on a lump of sugar, which is quite a common method of administering it. A few drops taken in this way several times a day will not infrequently cure a slight winter cough. It may also be given in capsules, in an emulsion, or in a mixture with other expectorants. It is sometimes employed as an inhalation, in some such way as the following: Terebene, 2; magnesium carbonate, 1; distilled water, 24; to be used in water, to 128, at a temperature of 60° C. (140° F.) in an apparatus so arranged that air can be drawn through it and inhaled.

TERPIN HYDRATE.

TERPINI HYDRAS.—Terpin Hydrate. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF TERPIN HYDRATE.

Terpin hydrate is an antiseptic, and it is stated that it will arrest the development of tubercle bacilli. It increases the secretion of the mucous membrane, and the functional activity of the kidneys.

THERAPEUTICS OF TERPIN HYDRATE.

It has been given as an antiseptic in acute and chronic bronchitis, when the secretion is unusually free, in whooping-cough, and, rarely, in the treatment of chronic nephritis, chronic cystitis and gonorrhœa.

BALSAM OF TOLU.

BALSAMUM TOLUTANUM.—Balsam of Tolu. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Syrupus Tolutanus.**—Syrup of Tolu. **Dose, 16 c.c. (4 fl. dr.).**
2. **Tinctura Tolutana.**—Tincture of Tolu. **Dose, 2 c.c. (30 ♏).**

ACTION OF BALSAM OF TOLU.

In action, as well as in composition, though it contains more benzoic acid, it resembles the balsam of Peru.

THERAPEUTICS OF BALSAM OF TOLU.

It is used only as an expectorant and, on account of its grateful taste, to flavor medicines, particularly cough mixtures. The syrup is almost always prescribed.

STORAX.

STYRAX.—Storax. **Dose, 1 gm. (15 gr.).**

ACTION OF STORAX.

Its action is the same as that of the balsam of tolu and of benzoin, and also resembles that of copaiba.

THERAPEUTICS OF STORAX.

Storax is a serviceable application to stimulate and disinfect ulcers. Mixed with an equal part of olive oil, it is used in some diseases of the skin requiring slight stimulation, and also as a parasiticide in scabies and pediculosis. In the form of an ointment it is recommended for the ulcerations of frost-bite. Internally it has been employed to some extent in the treatment of gonorrhœa, gleet and catarrhal affections of the genito-urinary organs. At present its principal internal use is as an expectorant in the compound tincture of benzoin.

SANGUINARIA.

SANGUINARIA.—Sanguinaria. (Bloodroot.) **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Preparations.

1. **Fluidextractum Sanguinariæ.**—Fluidextract of Sanguinaria. **Dose, 0.1 c.c. (1½ ♏).**
2. **Tinctura Sanguinariæ.**—Tincture of Sanguinaria. **Dose, 1 c.c. (15 ♏).**

ACTION OF SANGUINARIA.

Sanguinaria is an acrid emetic with, in large doses, narcotic powers; it is also expectorant and said to be an emmenagogue.

THERAPEUTICS OF SANGUINARIA.

It is chiefly used as a stimulating expectorant in chronic bronchitis or in advanced stages of the acute disease.

CREOSOTE.

CREOSOTUM.—Creosote. **Dose, 0.2 c.c. (3 ♏).**

Preparation.

Aqua Creosoti.—Creosote Water. **Dose, 8 c.c. (2 fl. dr.).**

Unofficial Preparation.

Creosoti Carbonas.—Creosote Carbonate. (Creosotal.) **Dose, 1 to 4 c.c.; 15 to 60 ♏.**

ACTION OF CREOSOTE.

The action of creosote, externally and internally, is practically the same as that of phenol.

THERAPEUTICS OF CREOSOTE.

Before the introduction of carbolic acid it was employed externally as a mild anæsthetic and a parasiticide, as well as a stimulating antiseptic, and internally to relieve vomiting and flatulence. It is really superior to phenol as an antipruritic, but is not much used on account of its acrid and penetrating odor. When applied on cotton to the cavity, it is efficient in relieving the aching of a carious tooth, and in the form of creosote water is valuable as a hæmostatic. The most important use of creosote is as a pulmonary antiseptic, administered by the mouth, hypodermatically, or by inhalation. In cases of tuberculosis it can be administered in the form of an emulsion with cod-liver oil and acacia; or with the hypophosphites and cod-liver oil; or with the syrup of wild cherry and acacia (.12 c.c. of creosote to 4 c.c. (1 fl. dr.) of emulsion in each case), or in a mixture of glycerin and whiskey. The dose of creosote should be .03 to .12 c.c. (½ to 2 ♏), given thrice daily, and increased to 1.20 to 1.50 c.c. (20 to 25 ♏) in the twenty-four hours, by easy stages. Administered in the form of enteric pills (which will dissolve only in the intestinal fluids), a daily dosage of 3 to 3.30 c.c. (45 to 50 ♏) can be reached without inconvenience. This method is preferable to that of Sommerbrodt, which consists in the administration of .06 c.c. (1 ♏) of creosote in .12 c.c. (2 ♏) of cod liver oil, in capsules. The method of hypodermatic injection in sterilized olive oil requires a special apparatus, is very tedious, somewhat painful, and altogether irksome to patient and physician. By inhalation creosote is employed with equal parts of alcohol and spirit of chloroform, or in alcohol, one part to eight, in a perforated zinc inhaler, of which 1 c.c. (15 ♏) is placed upon a bit of cotton and used for fifteen minutes in every hour. If the best beechwood creosote is employed, no untoward results are likely to be obtained. If the dose is increased too rapidly there may occur some nausea, epigastric uneasiness, and even vomiting. Disturbance of the kidneys has been produced, and the urine then presents practically the same appearances as after the ingestion of phenol (*see* p. 56). The stomach symptoms have been relieved by the patient's placing himself upon his back, for half an hour after administration of the remedy. It is quite likely that the patient acquires a tolerance, for the daily dose of 20 c.c. (300 ♏) has been given for a considerable time, with benefit, although 3.30 c.c. (50 ♏) should be considered as the maximum daily dose. Creosote is more efficient than either of its principal constituents, guaiacol or creosol, even if given in proportionate dose.

Creosote carbonate (not official), which contains 92 per cent. of creosote, does not possess the caustic and irritative properties of the pure creosote, and can be administered in dose of from 1 to 4 c.c. (15 to 60 ♏) in a wineglass of sherry after meals. As it is slowly absorbed, it is probable that it is eliminated for the most part by the bronchial mucous membrane. Since it does not irritate the gastro-intestinal tract nor the kidneys, it is the method of choice in the treatment of pulmonary tuberculosis. Creosote carbonate is also highly esteemed in the treatment of pneumonia, and under its use, as in the case of sodium salicylate, defervescence is much more frequently by lysis than by crisis, which is ordinarily the rule in this disease.

GUAIACOL.

GUAIACOL.—Guaiacol. (Methyl Pyrocatechin.) **Dose, 0.5 c.c. (8 ♏).**

Preparation.

Guaiacolis Carbonas.—Guaiacol Carbonate. **Dose, 1 gm. (15 gr.).**

ACTION OF GUAIACOL.

Guaiacol is locally an antiseptic and its general action is similar to that of creosote, but it is less likely to irritate the intestinal canal and kidneys.

THERAPEUTICS OF GUAIACOL.

External.—If painted on the skin over an area of from 10 to 50 sq. cm. (4 to 20 square inches), it is capable of reducing pyrexia, but it is not used for this purpose on account of the sweating and collapse which it occasions.

Internal.—The carbonate is often employed as a substitute for guaiacol, and in many cases is preferable to it. Guaiacol.

especially the carbonate, has been used to a large extent in pulmonary tuberculosis, under the idea that it has a destructive effect upon the bacilli of the disease; but there is no absolutely certain evidence that such is the case. The carbonate has given excellent results in the treatment of typhoid fever in limiting the decomposition in the intestines.

D. ANTISPASMODICS.

GRINDELIA.

GRINDELIA.—Grindelia. **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Grindeliæ.—Fluidextract of Grindelia. **Dose, 2 c.c. (30 ♏).**

ACTION OF GRINDELIA.

By reason of its volatile oil, grindelia is gently stimulating to the stomach. In therapeutic doses it appears to have little or no action on the heart or arteries, but in large quantities it slows the heart by stimulating the vagi and raises blood-pressure by stimulating the vaso-motor centre. In these large doses it may also induce paralysis of the peripheral sensory nerves, the sensory centres in the spinal cord, and, finally, the motor centres and nerve-trunks. It is excreted by the bronchial mucous membrane, as well as by the kidneys, and at first slightly increases the secretion of mucus, but afterward diminishes it. It appears to have a special action in **relaxing** the **muscular coats** of the **bronchi,** and this is said to be through depression of the ends of the motor fibres of the vagus distributed to the parts and of the reflex centre in the medulla oblongata. The terminations of the sensory nerves supplying the bronchial mucous membrane are also said to be depressed. In the course of its elimination by the kidneys it excites more or less renal irritation, with increased urinary secretion.

THERAPEUTICS OF GRINDELIA.

In ivy poisoning rapid relief is often afforded by the application of cloths dipped in a mixture of the fluidextract with water. Such a mixture may also be used to allay the pain of herpes zoster and as a lotion for burns and blisters, as well as an injection in gonorrhœa, gleet, and vaginitis. One part of the fluidextract to four parts of water has been employed as a topical dressing in iritis, and diluted with glycerin or water this preparation makes a good application for chronic or irritable ulcers. On account of its property of relaxing the bronchial muscles, grindelia is one of the remedies most commonly resorted to for the relief of the symptom asthma, and two or three doses of 1.20 c.c. (20 ♏) of the fluidextract given every twenty minutes in milk (which prevents the precipitation of the resin) will often prove efficacious in arresting the paroxysms. Between the attacks this dose should be taken three times a day. Grindelia may also be combined advantageously with other asthmatic remedies, such as lobelia and belladonna. Grindelia leaves steeped in a saturated solution of nitre and dried are smoked in a pipe or burned on a plate, so that the patient may inhale the fumes as they rise. The leaves prepared in this way, and with or without the addition of tobacco, lobelia, stramonium, etc., may also be rolled into cigarettes and smoked. Cough by imitation and habit, whooping-cough, and the spasmodic difficulty of breathing which accompanies various pulmonary and cardiac diseases, hay-asthma, etc., are not infrequently helped by grindelia. It is often of service in subacute bronchitis, chronic bronchitis (especially of the aged), emphysema and bronchorrhœa, and is usually prescribed in association with other expectorants. The bitter taste of the drug is perhaps best covered by spirit of chloroform.

ERIODICTYON.

ERIODICTYON.—Eriodictyon. (Yerba Santa. Mountain Balm.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Eriodictyi.—Fluidextract of Eriodictyon. **Dose, 1 c.c. (15 ♏).**

ACTION OF ERIODICTYON.

Eriodictyon has long been used in California as a bitter tonic, and as a stimulating expectorant.

THERAPEUTICS OF ERIODICTYON.

It has been found useful in chronic bronchitis, and as it appears to have something of the anti-spasmodic action of grindelia, it is sometimes combined with that drug. In asthmatic attacks it has also been employed by smoking. It is an excellent vehicle for quinine, concealing its bitter taste.

OXYGEN.

Oxygenium.—Oxygen (unofficial).

ACTION OF OXYGEN.

The first effect of the inhalation of oxygen in the pure state (not as air) is a sensation of warmth in the respiratory passages. The appetite is increased, and a feeling of mental exhilaration and a disposition to greater bodily activity are produced. The pulse is generally quickened, but may be reduced in frequency. It has been shown that the administration of oxygen in from 40 to 90 litres (10½ to 23½ gallons) per day, given in two doses and mixed with a determinate quantity of air, energizes to some extent the nutritive functions, increases the appetite, slightly elevates the temperature, stimulates the cardiac movements, and augments the body-weight. These effects are chiefly attributable to the action on the blood; the red corpuscles being increased in number and stimulated to greater organic activity. The capacity of the blood for the absorption of oxygen, however, is limited, as the oxygen forms a definite chemical compound with hæmoglobin, and as soon as the latter is saturated, the blood will not take up any further amount. With the normal amount of oxygen in the air, the normal rapidity of the circulation, and the normal extent of lung surface, the blood is almost, but not completely, saturated, and it is this small difference between the possible and actual saturation which seems to be sufficient to cause some stimulation to the formation of red corpuscles. In disease the case is often very different, and when the absorption of oxygen is in any way impeded the blood passes through the pulmonary circulation before it has time to absorb all the oxygen it is capable of absorbing. There is, therefore, a very evident indication for an artificial supply of the gas for the more complete oxygenation of the blood.

Therapeutics of Oxygen.

Oxygen inhalations are used in cardiac disease, pneumonia, pulmonary œdema, emphysema, convulsions, chloroform narcosis, asphyxia from toxic gases, and in various other conditions characterized by great lividity or by dyspnœa due to causes interfering with the oxygenation of the blood. Even though they should fail to avert a fatal issue, they often greatly relieve the distress of the patient, and in many instances they are of material assistance in tiding over a temporary risk of death. In various chronic conditions, as anæmia, albuminuria, glycosuria and different forms of sub-oxidation, the persistent use of oxygen has given excellent results. There seems to be satisfactory evidence that it is beneficial in some cases of phthisis, especially those in which emaciation, dyspeptic symptoms, etc., have occurred without marked change in the condition of the lungs. When cavities have formed and hectic fever has set in, oxygen can be of service simply as a palliative of dyspnœa. In the administration of this remedy the gas should be allowed to issue in a gentle stream, and it is advisable that the inhaler should not be held too near the patient. The ordinary inhaling mouth-piece may often be replaced with advantage by a glass funnel three or four inches in diameter, and the latter should be held, an inch or so away, over the nose and mouth of the patient. Small doses of oxygen at frequent intervals are usually best.

Division IX.—DRUGS ACTING ON THE DIGESTIVE APPARATUS.

A. Drugs acting on the Teeth.—For cleaning the teeth, powders are commonly used, but soaps and liquid dentifrices are occasionally employed. Chalk, which acts mechanically, constitutes the basis of most tooth powders, and charcoal, which, however, may abrade the enamel, is also sometimes used for its mechanical effect. In order to prevent the decomposition of been thoroughly studied, and that it acts directly on the gland is shown by the fact that it prevents any increase of salivary secretion on stimulation of the chorda, although the vessels dilate as usual. It appears to act on the terminations of nerve fibres in the gland cells, but this action is limited to certain definite terminations, since the sympathetic secretory nerve fibres are not paralyzed, and it has been ascertained that not all the fibres of the chorda tympani are acted upon. Atropine would seem, then, to act upon the terminations of the secretory fibres, and to leave all others unaffected.

Antisialogogues falling under this heading are—

(1) **Belladonna,**
(2) **Hyoscyamus,**
(3) **Stramonium,** and
(4) **Nicotine** in excess.

4. *Antisialogogues acting reflexly by depressing the peripheral ends of afferent nerves.*—Such are alkalies, opium, and any substances allaying irritation of the mouth. Part of the effect of opium is due to its depressing action on the medullary centre.

Therapeutics.—A deficiency in the amount of saliva secreted is a prominent feature of belladonna poisoning, and it is also sometimes a disease in itself, being then probably of nervous origin. It is most commonly met with in fevers, the mouth becoming extremely dry and the patient suffering from thirst. Remedies which relieve this febrile thirst and impart a sensation of coolness are known as **Refrigerants.** In fever, acid drinks, such as lemonade, and beverages containing carbon dioxide gas are of service as sialogogues. For the condition known as "dry mouth" pilocarpus has been employed, and this is also useful in relieving the dryness caused by belladonna or atropine. Excessive salivary secretion is seldom met with except as a symptom of poisoning by such drugs as mercury, iodine and pilocarpus. In some forms of indigestion the saliva acquires a very disagreeable taste, or perhaps the secretion may become diminished; but here the correction of the difficulty is to be sought in the improvement of the digestion.

C. Drugs acting on the Stomach.—In the present state of our knowledge it is not possible to speak with accuracy of the special action of many of the drugs affecting the stomach, and it will therefore serve the most useful purpose to divide this class of drugs into those affecting the secretion of gastric juice as a whole, the secreted contents, the vessels, nerves, and movements of the stomach, and, lastly, those which are emetics.

1. *Drugs increasing the amount of gastric juice secreted.*—These are usually called **Stomachics**, and they include a large variety of agents. The secretion of gastric juice is reflexly augmented by all bitter and aromatic substances (which likewise increase the appetite), as well as by stimulants to the mouth. Indeed, the smell and taste of food constitute the most powerful stimulant to gastric secretion, and substances of agreeable flavor cause a marked increase in it by reflexes from the mouth and nose. The simple presence of food in the stomach also tends to promote the flow. The aromatics appear, like other volatile oils, to cause an irritation, hyperæmia and increased secretion and peristalsis, with consequent improvement in digestion and absorption. It is thought probable, though this has not been proved, that bitters also cause an irritation, leading reflexly to the same results. Their effects are, however, no doubt largely due to their acrid taste, which is very lasting.

(*a*) The drugs which increase the flow of gastric juice are—

(1) **Aromatics.**
(2) **Bitters.**
(3) All **alkalies** (especially potassium and sodium bicarbonates and aromatic spirit of ammonia).
(4) **Alcohol.**
(5) **Ether.**
(6) **Chloroform.**
(7) **Magnesium oxide.**
(8) **Magnesium carbonate.**
(9) **Pungent substances** (pepper, mustard).

Therapeutics.—Stomachics are extensively employed to favorably modify the digestive process in various functional disorders.

2. *Drugs decreasing the amount of gastric juice secreted.*

(1) **Mineral** acids.
(2) **Acetic** acid.
(3) Many of those in the last list if given in large doses, *e. g.*, alcohol, ether and chloroform.

Therapeutics.—These drugs, it may be stated, are never given for this purpose. It should be noted here that acids and alkalies have opposite effects as regards the gastric juice and the saliva. While acids diminish the secretion of the gastric juice, which is acid, they increase that of the saliva, which is alkaline; alkalies, on the other hand, diminish the secretion of the alkaline saliva, but increase that of the acid gastric juice.

3. *Drugs altering the composition of the gastric contents.*—The reaction of the gastric contents may, of course, be modified by acids and alkalies. In cases of difficult digestion due to a deficient secretion of hydrochloric acid, diluted mineral acids are often prescribed, and they should be taken about two hours after eating, so as not to interfere with the secretion of the natural acid. If, on the other hand, there appears to be an excess of acid in the stomach, alkalies are ordered at meal-times, and sodium bicarbonate is the one generally selected. When it is thought that the secretion of pepsin is at fault, pepsin is administered, and it is customary to prescribe it with diluted hydrochloric acid. In order to prevent fermentation and putrefaction in the stomach, **antiseptics** are employed. In all varieties of indigestion it should be borne in mind that it is of much greater importance to remove the primary cause of the trouble than to endeavor to modify the composition of the gastric contents.

Drugs which have been used for this purpose are—

(1) **Phenol.**
(2) **Iodoform.**
(3) **Boric acid.**
(4) **Creosote.**
(5) **Eucalyptus.**
(6) **Thymol.**
(7) **Resorcinol.**
(8) **Salicin.**
(9) **Bismuth subsalicylate.**
(10) **Phenyl salicylate.**
(11) **Sodium thiosulphate.**
(12) **Sodium phenolsulphonate.**
(13) **Sulphurous anhydride.**
(14) **Naphthol.**
(15) **Charcoal.**

Charcoal has been considered by many to be useless when it is moist, but it has been shown that when moist it is capable of absorbing the gases from decomposing matter almost as readily as when in the dry state.

4. *Drugs which dilate the vessels of the stomach.*—The vascularity of the stomach is very readily affected. Thus, mechanical irritation, such as results from the presence of food, and particularly peptones, causes a considerable dilatation of the vessels. Such increased vascularity, if not excessive, is advantageous, since it tends to promote absorption, as well as gastric secretion. The substances which increase the vascularity of the stomach are: all stomachics (except alkalies), diluted mineral acids, the drugs which have been already enumerated as irritants generally, and squill, digitalis, colchicum, senega, copaiba, gamboge, guaiac and veratrine. Most of these, however, produce, even in small doses, too powerful an irritant effect to be of service in this regard, and practically the only class of drugs much employed to increase gastric vascularity is the stomachics. Even these may induce gastritis, if used to excess, as is constantly seen in the case of alcoholics.

Gastro-intestinal irritants.—It will be found that in the description of the action of drugs a large number are designated as gastro-intestinal irritants. Caustic potash and mineral acids such as nitric and sulphuric acids are very powerful agents of this class, and the reader is referred to the sections on these drugs for a narration of the local and general symptoms produced. There is naturally a great variation in the severity of the effects of different gastro-intestinal irritants, and it is worthy of note that many of them have no action on the mouth.

5. *Drugs which contract the gastric vessels.*—These have already been mentioned as being generally astringent. As they are much more frequently employed for intestinal disorders than for those of the stomach, their detailed consideration is deferred to the section on drugs acting on the intestines.

6. *Drugs acting on the nerves of the stomach.*—The terminal branches of the right and left pneumogastric nerves, which supply the stomach, are markedly affected by all powerful gastric irritants, with the causation of severe pain; while drugs which are only mildly irritant to the stomach give rise merely to a sensation of warmth, which is often agreeable, rather than otherwise. It is, of course, never desirable to produce gastric pain.

(6) *Gastric Sedatives.*—These drugs are the same as those which are local sedatives to other parts of the body. Those most used for the stomach are—

(1) **Bismuth subcarbonate.**
(2) **Bismuth subnitrate.**
(3) **Bismuth subsalicylate.**
(4) **Opium.**
(5) **Hydrocyanic acid.**
(6) **Carbon dioxide.**
(7) **Belladonna.**
(8) **Hyoscyamus.**
(9) **Stramonium.**

They are most commonly employed in the various painful forms of dyspepsia, and all of them, with the possible exception of stramonium, are in constant use.

7. *Drugs acting on the movements of the stomach.*—As it has been observed that the movements of the stomach increase proportionately with an increased acidity of the gastric contents, it would appear that anything which causes an increase of acidity will tend to produce more pronounced movements. In addition, stomachics seem to promote the movements, while strychnine has been thought to directly stimulate the unstriped muscle of the gastric wall. Many authorities, however, believe that the latter has no such specific action, but affects the digestion merely in the same way as the simple bitters. Under this class of drugs we have, then, mineral acids, stomachics, and nux vomica, and as an adequate amount of gastric movement is essential to the digestive process, they are of great value in the treatment of dyspepsia.

Carminatives.—This term is usually applied to substances which promote the expulsion of gas from the stomach and intestine by increasing peristalsis, stimulating the circulation, and perhaps relaxing the two orifices of the stomach. Many of them are also antiseptics. The most efficient carminatives are—

(1) **Stomachics** generally.
(2) **Aromatics** especially.
(3) **Bitters,**
(4) **Pungent substances,**
(5) **Valerian,**
(6) **Asafetida,**
(7) **Camphor,** and
(8) **Volatile oils.**

8. *Emetics.*—The act of vomiting is a reflex one, and is controlled by a nerve centre in the medulla which is situated near

and closely related to the respiratory centre. This may respond to afferent impulses reaching it from many organs, as the cerebrum (through the special senses), the various parts of the alimentary canal, the gall bladder, the genito-urinary tract, etc. Disturbance of the mechanism of equilibrium, as in vertigo and seasickness, is also a common cause of vomiting. Numerous drugs which, by their action on special organs, are capable of reflexly stimulating the vomiting centre might be included among emetics, but it is customary to limit this designation to those which produce vomiting either by acting on the stomach or on the medullary centre. The first class are sometimes called **direct** emetics, and the second, **indirect** emetics, but as certain authors use these terms in just the opposite way, making the direct emetics those which act on the centre, it will be more satisfactory to divide emetics into gastric, or local, and central, or general. The following experiments have been employed to determine the mode of action of the different emetics:

1. If when the drug has been injected directly into the circulation (preferably into the carotid artery, on account of its nearness to the medulla), it is found that vomiting results very promptly, it is concluded that the action is on the centre. If, however, a considerable time elapses between the injection and the production of vomiting, the conclusion is reached that the action is on the stomach and that the drug must have been excreted into this organ before vomiting could be caused.

2. If the smallest amount of the drug which is capable of causing vomiting when injected into the circulation is larger than is required when it is introduced directly into the stomach, it is concluded that the primary action is on the stomach and that such vomiting as follows its injection into the circulation is due to the fact that a portion of the drug has been excreted into the stomach.

3. If when the stomach has been replaced by a bladder no vomiting results from its injection into the circulation, it is concluded that the drug acts on the stomach; but if vomiting takes place under these circumstances, the inference is that the action is on the centre, the vomiting being caused by the contraction of the abdominal muscles.

4. If, when the drug has been introduced into the stomach, a long time elapses before vomiting is produced, it is concluded that the action is on the centre, the delay being due to the time required for the absorption of the drug.

It has been found, however, that such experiments are not altogether reliable, since some emetics act both locally and centrally, and, moreover, some of them, in the course of their circulation through the blood, probably act on some of the numerous organs from which impulses are transmitted to the vomiting centre.

The following are the emetics most commonly used:

Emetics acting on the stomach:

(1) **Yellow mercuric subsulphate.**
(2) **Alum.**
(3) **Ammonium carbonate.**
(4) **Copper sulphate.**
(5) **Zinc sulphate.**
(6) **Sodium chloride.**
(7) **Ipecacuanha.**
(8) **Mustard.**
(9) **Warm water.**

Ipecacuanha has often been classed among emetics which act on the centre, but it has been demonstrated that emetine, like many other irritants when injected subcutaneously, has a specific action on the alimentary canal, and, according to the best authorities, almost all the facts brought forward as evidence of the supposed central action of the drug have now been disproved (*see* p. 517).

Emetics acting on the medullary centre:

(1) **Apomorphine.**
(2) **Tartar emetic.**
(3) **Senega.**
(4) **Squill.**

Apomorphine and tartar emetic are very powerful, and much more depressant than the ordinary local emetics. Tartar emetic, however, acts partly on the stomach, and by many it is believed that the vomiting caused by it is mainly due to gastric irritation.

Therapeutics.—Emetics are employed for three purposes: (1) To evacuate the stomach. This is a very important indication in most cases of poisoning. In many instances, however, washing out the stomach is preferable to the use of an emetic. Emetics, as apomorphine, given subcutaneously, sometimes aid the expulsion of foreign bodies which have become impacted in the fauces or œsophagus. When with a distended stomach there is a feeling of nausea, and also in certain cases of sick headache, the emptying of the stomach may afford relief. Emetics were formerly employed in a great variety of conditions in which their use is now obsolete. (2) To expel the contents of the air-passages. Thus, an emetic often aids the expulsion of a foreign body lodged in the larynx. This class of drugs is especially useful in infants and young children, who cannot expectorate well, to clear the air-passages in bronchitis, laryngitis, diphtheria, etc. (3) To produce nausea. The dose for this purpose is usually about one-tenth of the emetic dose. The nauseant stage is employed principally in the treatment of catarrhal conditions and coughs, and it is indicated when the mucous secretion is deficient or thick and tenacious. The milder emetics should be chosen, as the nauseant stage is to be prolonged without the production of actual vomiting.

On account of the straining induced by the vomiting, emetics are as a rule contra-indicated in cases of aneurism, hernia, peritonitis, prolapse of the uterus or rectum, and where there is a tendency to hæmorrhage.

9. *Anti-emetics.*—The causes of vomiting being so numerous, the number of agents which may serve as anti-emetics is also very large; but, as in the case of emetics, only those substances will be considered which act either on the stomach or on the vomiting centre.

Anti-emetics acting on the stomach.—These are all those substances which have been already enumerated as having a sedative influence on the gastric nerves (*see* p. 540).

Also some drugs which occasionally appear to have a specific local action in arresting vomiting; such are:

(1) **Cocaine.**
(2) **Cerium oxalate.**
(3) **Menthol.**
(4) **Wine of ipecac.**
(5) **Tincture of iodine.**
(6) **Arsenic trioxide.**
In minute doses.
(7) **Alcohol.**

(8) **Phenol.**
(9) **Chloroform.**
(10) **Creosote.**
(11) **Ether.**
(12) **Silver nitrate.**
(13) **The phenolsulphonates.**
In small doses.

Anti-emetics acting centrally—

(1) **Opium.**
(2) **Ammonium bromide.**
(3) **Potassium bromide.**
(4) **Sodium bromide.**
(5) **Hydrated chloral.**
(6) **Amyl nitrite.**
(7) **Nitroglycerin.**
(8) **Diluted hydrocyanic acid.**
(9) **Alcohol.**

It will be noticed that some drugs fall under both headings.

Therapeutics.—The really efficient way to treat vomiting is to remove the cause, but, of course, this is not always possible. These drugs are, indeed, only palliative, and all are quite uncertain. Sometimes, however, one will be successful in controlling vomiting where a number of others have failed. Perhaps the most trustworthy anti-emetics are ice, diluted hydrocyanic acid, carbon dioxide, bismuth salts, morphine and menthol.

D. Drugs Acting on the Intestines.—Owing to various circumstances, among which may be mentioned the lack of accurate knowledge regarding both intestinal physiology and pathology and the fact that many drugs are altered in composition by the time they reach this portion of the alimentary tract, it is as yet impossible to classify the drugs acting on the intestines upon a physiological basis. We have, in fact, only three important divisions: purgatives, antiseptics and astringents.

One of the methods of experimentation which has been used to determine the mode of action of purgatives is as follows: The intestine is cut across in two places a short distance apart; the isolated part, still attached to the mesentery, is sewed up at one end; the other, the open end, is attached to the abdominal wall, thus giving a test-tube-like piece of intestine in which drugs can be placed. The parts of the bowel on either side of the excised piece are then sewed together, so that the whole intestine is the same as before, with the exception of being a little shorter. The results of this method not having proved very satisfactory, another was devised, which seems more trustworthy. Four ligatures are put around the intestine at equal distances apart, so that three pieces are shut off from the rest of the intestine and from each other, each of the same length. With a fine syringe the drug to be experimented upon is injected into the middle piece, and the whole returned into the abdominal cavity. In a few hours the animal is killed, and the state of the interior of the middle piece is contrasted with that of the pieces on either side of it. Before these experiments there had been much discussion as to whether some purgatives did not act only by increasing the action of the muscular coat, and others only by stimulating the secretions; but from such experiments it appears that probably the majority act in both ways, some very slightly on the secretion and powerfully on the muscle, and others slightly on the muscle and powerfully on the secretion. We will first consider intestinal purgatives, then intestinal antiseptics, and finally intestinal astringents.

(*C*) **Purgatives** are divided into the following classes:

Laxatives.—These are substances which slightly increase the action of the bowels, chiefly by stimulating their muscular coat.

They are—

(1) **Honey.**
(2) **Most fruits,** especially—
(3) **Tamarind,**
(4) **Fig,**
(5) **Prune.**
(6) **Manna.**
(7) **Cassia fistula.**
(8) **Sulphur.**
(9) **Magnesium oxide.**
(10) **Olive oil.**
(11) **Castor oil** (small doses).

Most of these are well known domestic remedies, and many of them are habitually used as articles of diet by persons inclined to constipation. Ergot, physostigma, nux vomica, belladonna, hyoscyamus, and stramonium are also laxatives, but are not used except under medical direction. Nux vomica is thought to increase the tone of the intestine, and is frequently prescribed in association with purgatives. In small doses belladonna increases peristaltic movements, for the reason that it paralyzes the inhibitory fibres of the splanchnics. In moderate doses, however, it completely arrests peristalsis, and it is largely given for this purpose, especially in combination with opium. Hyoscyamus has a similar action, and in small doses is frequently combined with the stronger purgatives in order to counteract the irregular contractions they induce, and thus prevent griping.

Ergot and physostigma are almost never employed for their laxative effect. Ergot, however, so often produces diarrhœa that its purgative action should be kept in mind.

Simple Purgatives.—These are somewhat more powerful in their action than laxatives; promoting peristalsis and also increasing intestinal secretion. Some of the laxatives, as castor oil and magnesia, when given in large doses act as simple purgatives.

The simple purgatives are—

(1) **Aloes.**
(2) **Rhubarb.**
(3) **Frangula.**
(4) **Cascara sagrada.**
(5) **Senna.**
(6) **Oxgall.**

All of these are constantly prescribed, and each has its special indications, which will be pointed out when their several actions are described.

Drastic Purgatives, often called Cathartics.—These cause markedly increased secretion and peristaltic movements, and in large doses severe irritation of the intestine, characterized by excessive secretion of mucus, pronounced vascular dilatation—possibly hæmorrhage—and profuse loose stools. This condition is attended with intense abdominal pain and tends to produce collapse. It is customary to prescribe hyoscyamus or belladonna with these drugs on account of the irregular peristalsis and severe griping pain which would otherwise be induced. The drastic purgatives are as follows:

(1) **Calomel.**
(2) **Podophyllum.**
(3) **Leptandra.**
(4) **Aloes.**
(5) **Jalap.**
(6) **Scammony.**
(7) **Gamboge.**
(8) **Colocynth.**
(9) **Elaterin.**
(10) **Croton oil.**

The most powerful are placed last. Some, as jalap, elaterin and scammony, are often called **hydragogue**, because of the large amount of secretion they excite.

Therapeutics.—These drugs are very useful in severe constipation, and are also frequently given for the purpose of withdrawing fluid from the body in consequence of the watery evacuations they occasion. Thus, for instance, jalap is in constant use to fulfill this indication in Bright's disease.

Saline Purgatives.—The action of these is obscure. They differ from the vegetable purgatives in not inducing intestinal irritation, unless when given in very large quantities. They are absorbed from the intestine very slowly, probably because they fail to penetrate into the cells, just as the salts of the heavy metals fail to penetrate the red blood-corpuscles. There being a distinct affinity between the intestinal epithelium and sodium chloride, but only a much weaker one between it and the saline cathartics, the latter do not permeate it. It seems certain that these cathartics very greatly increase the secretion of intestinal fluid, and hinder its reäbsorption, so that a large amount of it accumulates in the intestine. Secretion goes on till the fluid in the intestine has become a 5 or 6 per cent. solution of the drug, so that if a very concentrated solution is given, much intestinal fluid is secreted. This tends to excite peristalsis mechanically, and, in addition, a salt stimulation results from the withdrawal of liquid and salts from the cells, as well as from the slight absorption of the salt itself; consequently there are produced an increased quantity and number of stools of fluid consistency. It has been denied that catharsis results if the salts are injected into the blood, but in medical practice it has been repeatedly demonstrated that magnesium sulphate, administered hypodermatically, purges. It is possible that other salines may act similarly. The saline purgatives are—

(1) **Potassium and sodium tartrate.**
(2) **Potassium bitartrate.**
(3) **Potassium sulphate.**
(4) **Sodium sulphate.**
(5) **Sodium tartrate.**
(6) **Sodium citrate.**
(7) **Sodium phosphate.**
(8) **Magnesium sulphate** and other salts.

Therapeutics.—These are very largely used as habitual purgatives, and such salts constitute the essential ingredient of the various cathartic mineral waters, such as Hunyadi János, Apenta, Pullna, Friedrichshall, Æsculap, Rubinat, Villacabras, etc. The most efficient way of using them is to add some hot water to the required dose of the salt or mineral water in a tumbler and slowly sip it in the morning.

Cholagogue purgatives will be considered under the heading of Drugs Acting on the Liver.

Enemata.—Any fluid preparation, injected into the rectum is called an enema. It is customary to give purgatives in this way when there is danger of their exciting nausea or when, in consequence of peritonitis or of obstruction, ulceration or other affection of the intestines, it is unadvisable to administer them by the mouth. Castor oil, olive oil, soap, aloes and magnesium sulphate are among the substances most commonly employed for purgative enemata, enough of the vehicle selected for the injection being used to make an enema of at least 350 c.c. (¾ pint). Such large enemata act mainly by distending the bowel and thus exciting peristalsis, though the soap or other agent employed no doubt has an irritating effect in addition. Attention has recently been drawn, however, to the use of purgatives by enema with only 4 to 12 c.c. (1 to 3 teaspoonfuls) of fluid. With the small enema, of course, there is no distention, and the movement is produced solely by the irritant action of the drug which is given in it. It is found that colocynthine (.01 to .03 gm.; ⅙ to ½ gr.), aloin (.4 to .5 gm.; 7 to 8 gr.), and cathartinic acid (.6 gm.; 10 gr.), dissolved in glycerin, will cause purgation in periods varying from half an hour to twelve hours. Colocynthine acts the most promptly and efficiently, the other two being certain in their effects only when the constipation present is of moderate degree. The action of the purgatives is attributed to absorption from the rectum. A teaspoonful (4 c.c.) of glycerin injected into the rectum, or the same amount given as a suppository, often promptly opens the bowels.

(*d*) **Intestinal Antiseptics.**—These are believed to check fermentation and putrefaction in the intestines and are—

(1) **Naphthol.**
(2) **Bismuth naphtholate.**
(3) **Naphthalene.**
(4) **Bismuth subsalicylate.**
(5) **Phenyl salicylate.**
(6) **Chlorine.**
(7) **Creosote.**
(8) **Corrosive mercuric chloride.**
(9) **Oil of turpentine.**
(10) **Silver nitrate.**

Naphthol has been shown to destroy micro-organisms *in situ.* Bismuth naphtholate has not the irritating properties of naphthol, but appears to be equally effective. When pure, naphthalene is not absorbed, it does not cause toxic symptoms, nor is there any change in the urine. Phenyl salicylate decomposes only in an alkaline solution, and this is useful for action in the small intestine. Chlorine water has been used for the disinfection of the intestine in typhoid fever. Creosote is valuable if administered in the form of enteric pills, which are soluble only in the intestinal fluids. Corrosive mercuric chloride is too poisonous for use, save in exceptional cases. Brilliant success has been achieved with oil of turpentine in the treatment of typhoid fever. Silver nitrate has a limited use as an antiseptic, in its local application to dysenteric ulcerations within reach in the rectum and sigmoid flexure. The intelligent use of the foregoing drugs has greatly improved the success of the treatment of the various forms of enteritis, diarrhœa, colitis, dysentery and typhoid fever.

Intestinal Astringents.—These may be described under the following heads:

Astringents acting on the vessels of the intestine.—These are the same as those acting on vessels generally. Those employed for their action on the intestine are—

(1) **Lead salts.**
(2) Dilute **solutions** of **silver** salts.
(3) **Alum.**
(4) Diluted **sulphuric acid.**

Astringents coagulating albuminous fluids and thus constricting the vessels:—

(1) **Tannic acid,** and all substances containing it, as—
(2) **Krameria,**
(3) **Kino,**
(4) **Hæmatoxylon,**
(5) **Cinnamon,**
(6) **Gambir,** and
(7) **Eucalyptus gum.**
(8) **Lead salts,**
(9) **Silver salts,**
(10) **Zinc salts,**
(11) **Bismuth salts,**
(12) **Copper salts,** and especially
(13) **Ferric salts.**

Astringents diminishing the amount of intestinal fluid secreted:

(1) **Opium.**
(2) **Lead salts.**
(3) **Calcium salts.**

The precise action of these is obscure, but it is probable that they operate in the way indicated.

Astringents diminishing the contractions of the muscular coat of the intestines:

(1) **Opium.**
(2) **Belladonna.**
(3) **Hyoscyamus.**
(4) **Stramonium.**
(5) **Lead salts.**
(6) **Lime.**
(7) **Bismuth salts.**

Therapeutics.—The most important point in the treatment of diarrhœa is to remove the cause, if possible. Not uncommonly the cause is the presence of irritating matters in the intestine, and a mild purgative, such as castor oil or rhubarb, is indicated to remove them. In many instances a certain amount of enteritis appears to be present in diarrhœa, and remedies serving to constrict the dilated vessels and to diminish intestinal movements and secretion are called for. Hence, it is often advantageous to combine two or more astringents. Opium has long been recognized as an agent of very great value in diarrhœal diseases, and is a very frequent ingredient in prescriptions employed for them. In such troubles, however, it must be remembered that drugs constitute only a small part of the treatment. It is essential that the diet should be very carefully regulated, and if the case is at all severe, absolute rest and attention to keeping the patient warm are called for. If there is a persistent cause, as tuberculous ulceration, palliation of the symptoms is generally all that can be looked for.

E. Drugs Acting on the Liver.—The liver has several distinct functions; viz.: (*a*) to secrete bile; (*b*) to form and store up glycogen; (*c*) to form urea; (*d*) to excrete substances absorbed from the intestine; and (*e*) to destroy poisonous substances absorbed from the intestine.

1. *Drugs Influencing the Secretion of Bile.*—Because an in-

creased amount appears in the fæces it does not necessarily follow that more bile is secreted. Thus, it may be that the gall bladder and ducts have been thoroughly emptied, or that the bile which has been poured into the duodenum has been swept along quickly before reabsorption, which is ordinarily rapid, has had time to take place. Drugs which increase the amount of bile actually secreted are called **direct cholagogues.** They are also sometimes spoken of as **hepatic stimulants,** but this is an unsatisfactory designation on account of the liver's having so many different functions. Drugs which simply lead to a larger amount of bile being found in the fæces, without any additional secretion, are called **indirect cholagogues.**

Direct Cholagogues.—These have been studied in fasting, curarized dogs. A canula having been inserted into the bile-duct, in order to conduct the fluid outside the body, the amount of bile secreted before and after the administration of the drug under experiment is noted. A fasting state is essential because food itself causes a considerable increase in the biliary flow.

Direct cholagogues (the most powerful being placed first) are—

(1) **Euonymus.**
(2) **Sodium benzoate.**
(3) **Sodium salicylate.**
(4) **Podophyllin.**
(5) **Leptandra.**
(6) **Corrosive mercuric chloride.**
(7) **Sodium sulphate.**
(8) **Sodium phosphate.**
(9) **Aloes.**
(10) **Ipecacuanha.**
(11) **Diluted nitric acid.**
(12) **Diluted nitrohydrochloric acid.**
(13) **Colocynth.**
(14) **Colchicum.**
(15) **Potassium sulphate.**
(16) **Rhubarb.**
(17) **Jalap.**
(18) **Scammony.**

There are individual differences among direct cholagogues. Some increase the fluidity of the bile, while others have the opposite effect. Euonymin, sodium benzoate, sodium salicylate, Harrogate old sulphur spring, and Carlsbad water, all markedly increase both the total quantity and the solids. Podophyllin, on the other hand, increases the solids without affecting the quantity.

Indirect Cholagogues.—These appear to stimulate the upper part of the jejunum and the lower part of the duodenum, thus sweeping the bile on before there is time for it to be reabsorbed.

They are—(1) **Mercury,** especially **Calomel;** (2) most **Cathartic purgatives.**

Therapeutics.—Cholagogues are used for cases of digestive derangement in which hepatic disorder seems to be the cause of the trouble, and in order to secure the excretion of the bile, as well as the secretion of a proper amount, it is often advantageous to combine direct and indirect cholagogues. Bile being a stimulant to peristalsis, all cholagogues naturally have a purgative action. In cases of dyspepsia in which the liver is at fault careful attention to the diet is a matter of importance, and active exercise, such as horseback riding, rowing, etc., is of service in promoting the expulsion of bile from the gall-bladder and ducts.

ANTICHOLAGOGUES.—These decrease the quantity of the bile secreted, and are sometimes called **hepatic depressants.** Calomel, castor oil, gamboge, magnesium sulphate, opium and lead acetate have something of this effect, but it is not sufficiently pronounced to interfere with the therapeutic actions for which they are employed.

2. *Drugs modifying the glycogenic function of the liver.*—We will here refer to those drugs which cause sugar to appear in the urine, and to those drugs which diminish the glycogenic function of the liver.

DRUGS CAUSING SUGAR TO APPEAR IN THE URINE.—Until recently it was assumed that all these drugs acted on the liver, probably by increasing the amount of sugar made from the hepatic store of glycogen; but we now have reasons for thinking that sometimes the pancreas may be the organ at fault in diabetes, for its excision causes sugar to appear in the urine, and other symptoms of diabetes; also it has been suggested that perhaps some perversion of processes going on in muscles may cause diabetes. Therefore it is rash to assume that all drugs causing sugar to appear in the urine (glycosuria) must act on the liver. What little can be stated as to the mode of action of these drugs will be given when each individual drug is considered.

The drugs stated to cause glycosuria have already been mentioned (*see* p. 457).

DEPRESSANTS OF THE GLYCOGENIC FUNCTION.—**Phosphorus, arsenic,** and **antimony** diminish and may even arrest the formation of glycogen by the liver; they also cause fatty degeneration of the organ. In many instances of diabetes **opium, morphine** and **codeine** have a marked effect in diminishing the quantity of sugar in the urine.

3. *Drugs modifying the formation of urea by the liver.*—The quantity of urea excreted by the urine is increased by phosphorus, arsenic, antimony, ammonium chloride, and iron. Phosphorus may also lead to the appearance in the urine of leucin and tyrosin. There is some evidence that this drug causes an increase of the urea through its action on the liver, for in phosphorus poisoning that organ undergoes extreme fatty degeneration, and jaundice supervenes. Whether the other drugs act through the liver is uncertain, but antimony and arsenic, like phosphorus, are capable of producing general fatty degeneration. Very large doses of all these substances are required to increase the amount of urea in the urine, and they are not employed therapeutically for this purpose.

Opium, colchicum, alcohol and quinine are among the drugs stated to increase the quantity of urea excreted.

C. DRUGS ACTING ON THE STOMACH.

(*a*) **Stomachics.**

CALUMBA.

CALUMBA.—Calumba. (Columbo.) **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Fluidextractum Calumbæ.** — Fluidextract of Calumba. **Dose, 2 c.c. (30 ♏).**
2. **Tinctura Calumbæ.**—Tincture of Calumba. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF CALUMBA.

External.—Calumba is slightly antiseptic and disinfectant.

Internal. *Mouth.*—Calumba is a typical simple **bitter.** It irritates the terminations of the gustatory nerves in the papillæ and mucous membrane of the tongue, increasing the appetite and reflexly stimulating the salivary and gastric secretions. The reflex action of bitters has recently been particularly studied. In these experimental researches there was employed Pavlow's method of sham feeding in a dog in which œsophagotomy had been performed and a gastric fistula also established. The bitter substances, therefore, did not pass into the stomach, and the reflex effects of their presence in the mouth could be accurately judged. It was found that if a pledget of wool soaked in a solution of a bitter was put into the mouth immediately before food was administered, a marked stimulant effect upon gastric secretion resulted; but if the bitter was used fifteen to thirty minutes before the meal it was quite inefficacious. It is concluded, therefore, that these substances have the power of rendering gustatory sensations more acute and of exercising a temporary stimulant effect upon gastric secretion. For this purpose they should be given in small doses and in the form of tinctures (.60 to 1.20 c.c.; 10 to 20 drops).

Gastro-intestinal Tract.—The gastric nerves are probably stimulated, and a sort of artificial hunger produced. The digestion is improved, as there is vascular dilatation, and the secretion of gastric juice is increased by this, as well as by the arrival in the stomach of an increased amount of alkaline saliva; while the gastric movements also appear to be somewhat augmented. The stronger bitters have some tendency to increase intestinal peristalsis and act on the bowels. The secretions of the pancreas and the bile are unaffected by any of them. They are more or less antiputrefactive, and, by removing morbid states of the intestinal mucous membrane, they favor assimilation. Too large doses are apt to interfere with digestion and their long-continued use induces gastric catarrh and consequent indigestion. Calumba is rapidly absorbed. Like some other bitters, it is feebly anthelmintic.

Blood and Circulation.—The leucocytes of the blood are markedly augmented, which may possibly assist in the absorption of food, and the red corpuscles are also stated to be increased. Calumbin, when injected intravenously, has the effect of increasing the blood-pressure by stimulation of the vasomotor centre.

Berberine, an alkaloid found in calumba and many other vegetable drugs, is, in large doses, an irritant which gives rise to a yellow discoloration of the intestines and urine. It is never fatal when given by the mouth, but when injected subcutaneously or intravenously it causes convulsions and paralysis, and death is likely to result by asphyxia from failure of the respiratory centre.

THERAPEUTICS OF CALUMBA.

Calumba and other simple bitters are used with good effect in atonic dyspepsia, and are often of material service in cases of anæmia and weakness, and in convalescence from acute diseases. In general, they may be said to be most advantageous in debilitated conditions in which the stomach participates in a feebleness of all the various organs. Calumba is the mildest agent of its class, and may be used with safety in many instances when other bitters would be too irritating. The tincture in doses of a few drops is occasionally used for the relief of the vomiting of pregnancy and of seasickness. Also in diarrhœa due to relaxation of the mucous membrane (without the presence of any inflammation), and in the relaxation of the bowels following acute intestinal affections, the tincture may often be employed with benefit. In such cases it is sometimes combined with the tincture of deodorized opium. To permanently cure a disposition to the accumulation of flatus in the intestines an infusion is highly recommended which is made with calumba, ginger, senna and boiling water. Thread worms may be treated by the rectal injection (the patient being in the knee-chest position) of 250 c.c. (½ pint) of the infusion, which is made with calumba, 12, in cold water (to avoid extracting the starch).

The use of bitters ought to be combined, whenever possible, with measures designed to relieve the cause of the dyspepsia. They should not be given in too concentrated form, nor employed for too long a time continuously. They are contraindicated in acute and subacute inflammation of the stomach, or when the secretion of gastric juice is diminished as the result of organic disease. Neither should they be prescribed as stomachics during the continuance of acute febrile diseases. Should the appetite remain good, although the digestion is impaired, it will usually indicate that the indigestion is intestinal, and remedies other than the bitters are called for.

GENTIAN.

GENTIANA.—Gentian. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Extractum Gentianæ.**—Extract of Gentian. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Fluidextractum Gentianæ.**—Fluidextract of Gentian. **Dose, 1 c.c. (15 ♏).**
3. **Tinctura Gentianæ Composita.**—Compound Tincture of Gentian. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF GENTIAN.

Gentian has the same action as calumba and other simple bitters.

THERAPEUTICS OF GENTIAN.

It is given in the same kinds of cases as the other drugs of its class, and, on account of its more agreeable flavor, it is perhaps more widely used than any of the rest. The compound tincture is esteemed an excellent vehicle for the administration of cod liver oil, the digestion and assimilation of which it serves to promote.

QUASSIA.

QUASSIA.—Quassia. **Dose, 0.5 gm. (7½ gr.).**

Preparations.

1. **Extractum Quassiæ.**—Extract of Quassia. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**
2. **Fluidextractum Quassiæ.**—Fluidextract of Quassia. **Dose, 0.5 c.c. (8 ♏).**
3. **Tinctura Quassiæ.**—Tincture of Quassia. **Dose, 2 c.c. (30 ♏).**

ACTION OF QUASSIA.

Quassia is an aromatic bitter stomachic, which has the same action as calumba and gentian. In doses of .12 gm. (2 gr.) quassin is said in many individuals to produce burning in the throat and stomach, discomfort, headache, nausea and vomiting.

THERAPEUTICS OF QUASSIA.

As it contains no tannic acid, quassia is often prescribed with iron. On account of its intense bitterness it is objectionable to some patients, but it is a very useful remedy in the class of cases in which these bitters are given. It is regarded as especially serviceable in the dyspepsia of inebriates, and whenever there are much relaxation and digestive torpor it is apt to be efficient as a stomachic tonic. A goblet made of quassia-wood may be used, by allowing water to stand in it for a number of hours, for making an extemporaneous infusion of the drug. The infusions of quassia, gentian and calumba are frequently employed as vehicles for the administration of acids or alkalies, according to the requirements of the case, in gastric indigestion. 250 c.c. (½ pint) of the infusion (1 to 100 of cold water to avoid extraction of too much of the bitter principle), injected into the rectum, with the patient in the knee-chest position, may be used with advantage against thread-worms.

CALAMUS.

CALAMUS.—Calamus. (Sweet Flag.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Calami.—Fluidextract of Calamus. **Dose, 1 c.c. (15 ♏).**

ACTION OF CALAMUS.

Sweet flag is a simple bitter and feeble aromatic.

THERAPEUTICS OF CALAMUS.

It is used with advantage in pain or uneasiness in the stomach or bowels arising from flatulence, or as an adjuvant to purgative medicines.

BARBERRY.

BERBERIS.—Berberis. (Barberry.) **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Berberidis. Fluidextract of Berberis. **Dose, 2 c.c. (30 ♏).**

ACTION OF BARBERRY.

It is in moderate doses a stomachic tonic, and somewhat astringent. It is also credited with alterative qualities. In large amounts it is a gastro-intestinal irritant.

THERAPEUTICS OF BARBERRY.

Locally it has been used in conjunctivitis, and internally in a variety of chronic conditions for its alterative effect.

CHIRATA.

CHIRATA.—Chirata. (Chiretta.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Chiratæ.—Fluidextract of Chirata. **Dose, 1 c.c. (15 ♏).**

ACTION OF CHIRATA.

Chirata is a simple bitter, like calumba.

THERAPEUTICS OF CHIRATA.

It has the same uses as calumba and gentian, and in India, where it is more frequently employed than elsewhere, it is given considerably as a substitute for cinchona. It diminishes flatulency and acidity, and is thought to be especially serviceable in the dyspepsia of gouty subjects. As it contains no tannic acid, it can be prescribed in combination with the iron salts.

SERPENTARIA.

SERPENTARIA.—Serpentaria. (Virginia Snakeroot.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Serpentariæ.**—Fluidextract of Serpentaria. **Dose, 1 c.c. (15 ♏).**
2. **Tinctura Serpentariæ.**—Tincture of Serpentaria. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF SERPENTARIA.

Serpentaria is a bitter and a stimulating expectorant. In large doses it causes nausea, vomiting, colic, flatulence and rectal tenesmus, with frequent, but not watery stools. It is slightly diuretic and diaphoretic.

THERAPEUTICS OF SERPENTARIA.

It may be employed as a bitter stomachic, and is of considerable utility as a stimulant expectorant in capillary bronchitis, and in pneumonia of low grade, when ammonium carbonate is combined with it. It is seldom administered alone.

DANDELION.

TARAXACUM.—Taraxacum. (Dandelion.) **Dose, 8 gm. (120 gr.).**

Preparations.

1. **Extractum Taraxaci.**—Extract of Taraxacum. **Dose, 1 gm. (15 gr.).**
2. **Fluidextractum Taraxaci.**—Fluidextract of Taraxacum. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF DANDELION.

Dandelion is a simple bitter, promoting appetite and digestion. For a long time it was supposed to have some action in increasing the secretion of bile, but it has been shown that this idea has no foundation in fact. It is a mild laxative, however, and as such may, by reflex stimulation, have some effect in tending to evacuate the gall bladder. The vulgar name by which dandelion is known both in England and France suggests that it may be diuretic.

THERAPEUTICS OF DANDELION.

It is not nearly as frequently employed now as formerly, but is still occasionally prescribed as a laxative in catarrhal jaundice, in ascites from hepatic disease, and in some forms of dyspepsia. By German physicians particularly it has been given in combination with ammonium chloride. Its practical utility as a diuretic seems to be somewhat limited.

CLOVES.

CARYOPHYLLUS.—Cloves. **Dose, 0.250 gm. (250 milligm.) (4 gr.).**

OLEUM CARYOPHYLLI.—Oil of Cloves. **Dose, 0.2 c.c. (3 ℳ).**

EUGENOL.—Eugenol. **Dose, 0.2 c.c. (3 ℳ).**

ACTION OF CLOVES AND OIL OF CLOVES.

External.—Oil of cloves has [illegible] preparation [illegible] brane [illegible] the burning sensation to which it at first gives rise is followed by anæsthesia of the part.

Internal. *Mouth.*—In the mouth the effects just mentioned are naturally produced, and, in addition, the nerves of taste and smell are stimulated and the salivary glands excited to increased secretion.

Stomach.—Oil of cloves is preëminently stomachic and carminative, and its gastric effects constitute the most important part of its action. It has the characteristic action of the volatile oils, appearing to induce dilatation of the blood-vessels, to stimulate the secretion of the gastric glands, and to accelerate the movements of the stomach, in consequence of which there is more or less eructation of gas. The oil also acts as an antiseptic here, as elsewhere, and it thus no doubt hinders the development of yeasts and other organisms. As soon as it reaches the stomach a grateful sensation of warmth is experienced, and its whole action in the organ tends to increase appetite and digestion. By the stimulation of the gastric nerves the heart is reflexly stimulated to a certain extent, and the rate and force of the heart are consequently moderately increased.

Intestine.—Similar effects are believed to be produced in the intestine, though it is not positively known whether the peristaltic movements of the latter are increased by the volatile oils. At all events, flatulence and distention are relieved, an effect which may be due in part at least to the antiseptic action. It is well known that the colic caused by some of the more powerful purgatives is much diminished by the administration with them of oil of cloves and other volatile oils. It has been shown that the intestine, like the stomach, absorbs more rapidly in the presence of small quantities of these oils. Oil of cloves, like others of its class, is capable when given in sufficient quantity of exciting gastro-enteritis.

Excretion.—Oil of cloves is absorbed from the intestine, and in the course of its excretion exerts more or less irritant action on the kidneys and respiratory passages, the secretions of which it tends to disinfect.

Eugenol has the same general action as the oil of cloves, of which it is one of the chief constituents.

THERAPEUTICS OF CLOVES AND OIL OF CLOVES.

External.—The expense of oil of cloves is an objection to its free or frequent use. On account of its local anæsthetic action it is sometimes employed as an external application for neuralgias. It is more or less used in combination with other rubefacients, counter-irritants and antiseptics. It is of service, in an ointment made with lanolin, in some cases of eczema, and in lupus vulgaris its repeated application is said to cause separation of the epithelium and retrocession of the nodules. As a parasiticide it has been used for pediculosis. It is one of the remedies most commonly resorted to for the relief of the pain of carious teeth, and is an important constituent of many "toothache drops." It is sometimes employed to give a pleasant odor to liniments.

Internal.—In cooking, cloves are largely used for seasoning. The oil may be given as a stomachic or as a carminative for the relief of gastric or intestinal pain, and is sometimes combined with preparations of scammony, of castor oil, and of colocynth, to prevent griping. Its aromatic qualities render it an agreeable adjuvant to other remedies besides purgatives, and in minute doses it has been successfully given for severe vomiting. In gastric fermentation the following combination has proved quite efficient: .06 c.c. (1 ♏) each of the oils of cloves, cinnamon and peppermint, with .06 c.c. (1 ♏) of creosote, administered three times a day in a soft capsule containing about .36 c.c. (6 ♏) of olive oil.

ALLSPICE.

PIMENTA.—Pimenta. (Allspice.) **Dose, 1 gm. (15 gr.).**
OLEUM PIMENTÆ.—Oil of Pimenta. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF ALLSPICE.

The same as that of cloves and oil of cloves.

THERAPEUTICS OF ALLSPICE.

The uses, as well as the action, are the same as those of cloves and oil of cloves.

MYRISTICA.

MYRISTICA.—Myristica. (Nutmeg.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

Pulvis Aromaticus.—Aromatic Powder. **Dose, 1 gm. (15 gr.).**

Fluidextractum Aromaticum.—Aromatic Fluidextract. **Dose, 1 c.c. (15 ♏).**

OLEUM MYRISTICÆ.—Oil of Myristica. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF MYRISTICA.

Oil of myristica has the same action as that of other aromatic oils. Its effects after absorption appear to render it more toxic than most volatile oils. In addition to its aromatic and carminative qualities, it is possessed of considerable narcotic power, and, injected into the circulation of the dog, it has been found to produce profound sleep, with slowing of the circulation, and, if the dose is sufficiently large, loss of reflex activity.

THERAPEUTICS OF MYRISTICA.

For mild cases of ringworm a liniment composed of one part of the oil to three of olive oil may be employed as an elegant antiparasiticide. In itching and painful hæmorrhoids the following ointment affords relief: Powdered myristica, 8; tannic acid, 4; petrolatum, 31. Nutmeg is much used in cooking, as its volatile oil renders it an agreeable stomachic. In medicine powdered or grated nutmeg, or the volatile oil, is given as a carminative and anodyne for the relief of nausea or colic and, combined with other remedies, of diarrhœa. The narcotic properties of the drug make it of service at times in the treatment of delirium tremens.

CINNAMON.

CINNAMOMUM SAIGONICUM.—Saigon Cinnamon. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Fluidextractum Aromaticum.** — Aromatic Fluidextract. **Dose, 1 c.c. (15 ♏).**

2. **Pulvis Aromaticus.**—Aromatic Powder. **Dose, 1 gm. (15 gr.).**

3. **Tinctura Cinnamomi.**—Tincture of Cinnamon. **Dose, 2 c.c. (30 ♏).**

CINNAMOMUM ZEYLANICUM.—Ceylon Cinnamon. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

OLEUM CINNAMOMI.—Oil of Cinnamon. Oil of Cassia. **Dose, 0.05 c.c. (1 ♏).**

Preparations.

1. **Aqua Cinnamomi.**—Cinnamon Water. **Dose, 16 c.c. (4 fl. dr.).**

2. **Spiritus Cinnamomi.**—Spirit of Cinnamon. **Dose, 2 c.c. (30 ♏).**

CINNALDEHYDUM.—Cinnamic Aldehyde. **Dose, 0.05 c.c. (1 ♏).**

ACTION OF CINNAMON.

Oil of cinnamon has the same action as other aromatic oils. The bark, on account of its tannic acid, has considerable astringent property.

THERAPEUTICS OF CINNAMON.

Finely powdered cinnamon is sometimes of service in arresting nausea and vomiting, and in doses of 4 to 6 gm. (60 to 90 gr.), night and morning, is said to be efficient in acute dysentery. Cinnamon is much used as an ingredient of carminative and astringent powders and mixtures, and is also combined with purgatives to prevent griping. On account of its tannic acid it is incompatible with iron preparations. For counter-irritation, especially in children, a spice plaster made by placing Aromatic Powder between two layers of flannel and moistening it with hot whiskey or other form of alcohol, is sometimes employed.

SUMBUL.

SUMBUL.—Sumbul. (Musk Root.) **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Extractum Sumbul.**—Extract of Sumbul. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

2. **Fluidextractum Sumbul.**—Fluidextract of Sumbul. **Dose, 2 c.c. (30 ♏).**

ACTION OF SUMBUL.

Little is known positively of the effects of sumbul on the system, but its action appears to resemble that of the volatile oils in general, and it is usually classed with the substances having malodorous oils, such as asafetida and valerian. It is stomachic and carminative, and is regarded more particularly as an antispasmodic and nerve tonic. It stimulates appetite, improves digestion, and allays irregular nerve action. It is said to directly influence the cerebro-spinal nerve centres, and thus control spasm, restlessness and incoördination of movement dependent upon disturbances of their circulation.

THERAPEUTICS OF SUMBUL.

Sumbul may be given for its carminative effects in colic and flatulence. It is thought to be especially beneficial in depressed or excitable conditions of the nervous system, and among the affections in which it has been recommended are neuralgias occurring in hysterical subjects, hysteria in general, chlorosis, neurotic migraine, alcoholic and other insomnia, chorea, catarrhal and spasmodic conditions of the respiratory and genito-urinary tracts, nervous dyspepsia, neurasthenia, and the unrest of nervous females. It is usually associated with such other remedies as may be indicated by the condition present.

LAVENDER.

OLEUM LAVANDULÆ FLORUM.—Oil of Lavender Flowers. **Dose, 0.2 c.c. (3 ♏).**

Preparations.

1. **Spiritus Lavandulæ.**—Spirit of Lavender. **Dose, 2 c.c. (30 ♏).**
2. **Tinctura Lavandulæ Composita.**—Compound Tincture of Lavender. **Dose, 2 c.c. (30 ♏).**

ACTION OF OIL OF LAVENDER FLOWERS.

This has the same action as oil of cloves and other aromatic volatile oils.

THERAPEUTICS OF OIL OF LAVENDER FLOWERS.

In nervous headache a few drops of the oil are sometimes rubbed upon the temples. Its principal external use is as an agreeable stimulating ingredient of liniments and ointments, and the compound tincture is largely employed to color the Lotio Rubra (*see* p. 393) and other red lotions. Being a very palatable carminative and gastric stimulant, lavender is in constant use in the treatment of nausea, flatulence, gastralgia, etc., and as an adjuvant or corrigent of other medicines. In hysterical and other nervous conditions it is a pleasant antispasmodic, and it is used as a stimulant in fainting. As a tranquilizing remedy in various disturbed states of the system it is not infrequently combined with Hoffmann's anodyne (Spiritus Ætheris Compositus), which it renders less disagreeable to take. To calm nervous headache the oil may be used internally as well as externally.

PEPPERMINT.

MENTHA PIPERITA.—Peppermint. **Dose, 4 gm. (60 gr.).**

OLEUM MENTHÆ PIPERITÆ.—Oil of Peppermint. **Dose, 0.2 c.c. (3 ♏).**

Preparations.

1. **Aqua Menthæ Piperitæ.**—Peppermint Water. **Dose, 16 c.c. (4 fl. dr.).**
2. **Spiritus Menthæ Piperitæ.**—Spirit of Peppermint. (Essence of Peppermint.) **Dose, 2 c.c. (30 ♏).**

ACTION OF PEPPERMINT.

Oil of peppermint has the action of volatile oils in general. The feeling of coolness and numbness which sometimes attends the external application of these agents is particularly marked in the case of oil of peppermint, on account of the menthol in its composition. Like many other volatile oils, especially those containing a considerable amount of terpene, it is actively antiseptic.

THERAPEUTICS OF PEPPERMINT.

External.—The oil from the menthol contained in it is of value in many cases of neuralgia. The surface painted over with it should be covered with oiled silk to prevent evaporation. Similar applications may be made for the relief of myalgia and various rheumatic and gouty pains.

Internal.—Peppermint is very largely employed as an efficient stomachic and carminative (often in association with sodium bicarbonate), and also as a flavoring agent. An infusion ("peppermint tea"), 1 to 20 of water, is a popular household remedy to induce perspiration or promote diuresis in fevers or chills, as well as to relieve attacks of colic. For the latter purpose the spirit, in hot water, is more effective, and it is especially well suited to children. Peppermint water is in very general use as a component of carminative mixtures for infants.

SPEARMINT.

MENTHA VIRIDIS.—Spearmint. **Dose, 4 gm. (60 gr.).**

OLEUM MENTHÆ VIRIDIS.—Oil of Spearmint. **Dose, 0.2 c.c. (3 ♏).**

Preparation.

1. **Aqua Menthæ Viridis.**—Spearmint Water. **Dose, 16 c.c. (4 fl. dr.).**
2. **Spiritus Menthæ Viridis.**—Spirit of Spearmint. (Essence of Spearmint.) **Dose, 2 c.c. (30 ♏).**

ACTION OF SPEARMINT.

It has the same action as peppermint, but its effects are less pronounced.

THERAPEUTICS OF SPEARMINT.

The therapeutic applications of spearmint are the same as those of peppermint, but its oil is not so agreeable as oil of peppermint. The preparations are in less general use than those of peppermint.

ANISE.

ANISUM.—Anise. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

OLEUM ANISI.—Oil of Anise. **Dose, 0.2 c.c. (3 ♏).**

Preparations.

1. **Aqua Anisi.**—Anise Water. **Dose, 16 c.c. (4 fl. dr.).**
2. **Spiritus Anisi.**—Spirit of Anise. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF ANISE.

The action of oil of anise is the same as that of aromatic oils generally. Although anise imparts a peculiar taste to the milk of nursing women, it apparently does not augment the secretion, as is supposed by some.

THERAPEUTICS OF ANISE.

Anise is the pleasantest carminative for infants and young children, and the seeds are used in many culinary products as a condiment which tends to increase their digestibility. It probably has some slight efficacy as an expectorant, and it is employed to a considerable extent as an agreeable component of cough mixtures. It is also much used as a general flavoring agent.

CORIANDER.

CORIANDRUM.—Coriander. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

OLEUM CORIANDRI.—Oil of Coriander. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF CORIANDER.

Oil of coriander has the same action as other aromatic volatile oils.

THERAPEUTICS OF CORIANDER.

Coriander is used almost entirely for flavoring purposes, for disguising the taste of senna and rhubarb, and for preventing the griping of these and other purgatives.

FENNEL.

FŒNICULUM.—Fennel. **Dose, 1 m. (15 gr.).**

OLEUM FŒNICULI.—Oil of Fennel. **Dose, 0.2 c.c. (3 ♏).**

Preparation.

Aqua Fœniculi.—Fennel Water. **Dose, 16.0 c.c. (4 fl. dr.).**

ACTION OF FENNEL.

Oil of fennel has the same action as that of anise and other similar oils. It has been supposed to have the effect of increasing the secretion of milk, urine, perspiration and bronchial mucus, and also to act as an emmenagogue.

THERAPEUTICS OF FENNEL.

As one of the most grateful of the various aromatics, fennel is employed to quite a large extent as a stomachic and carminative, and as a corrective against the griping effects of purgatives. It is still sometimes used in hot infusion, as an adjuvant, in the treatment of amenorrhœa dependent on uterine congestion and for re-establishing the mammary secretion when suppressed. The infusion (not official, 1 to 60 of water) is given as an enema to infants for the expulsion of flatus.

CARAWAY.

CARUM.—Caraway. **Dose, 1 gm. (15 gr.).**

OLEUM CARI.—Oil of Caraway. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF CARAWAY.

The action of oil of caraway is the same as that of other aromatic volatile oils.

THERAPEUTICS OF CARAWAY.

Caraway is used chiefly as a flavoring agent and a carminative for flatulent colic, especially in infants. The seeds are often baked in cakes, which thus receive a pleasant aromatic taste and have the effect of stimulating the digestive organs.

PENNYROYAL.

HEDEOMA.—Hedeoma. (Pennyroyal.) **Dose, 8 gm. (120 gr.).**

OLEUM HEDEOMÆ.—Oil of Hedeoma. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF PENNYROYAL.

Pennyroyal is a gentle aromatic stimulant.

THERAPEUTICS OF PENNYROYAL.

It may be given in flatulent colic and sick stomach. The oil is in common use locally applied as a remedy for mosquito bites.

CHAMOMILE.

ANTHEMIS.—Anthemis. (Chamomile.) **Dose, 2 gm. (30 gr.).**

Action of Chamomile.

Chamomile has the general action of the aromatic volatile oils. Its oil is said to have the power of reducing reflex excitability in frogs, even after its excitation by strychnine or brucine.

Therapeutics of Chamomile.

Chamomile is more or less used as a stomachic and carminative. The infusion (not official, 1 to 20 of water) acts as an emetic when given in doses of considerable size. In smaller doses it is aromatic and carminative, and favors diuresis and the action of the skin. It is a popular household remedy for colds, dyspepsia and intestinal disorders.

GERMAN CHAMOMILE.

MATRICARIA.—Matricaria. (German Chamomile.) **Dose, 16 gm. (240 gr.).**

Action and Therapeutics of Matricaria.

These are identical with those of chamomile.

SAGE.

SALVIA.—Salvia. (Sage.) **Dose, 2 gm. (30 gr.).**

Action of Sage.

Sage has the action of volatile oils generally and is also astringent in consequence of its tannic acid. The oil has been shown to occasion epileptiform convulsions in dogs.

Therapeutics of Sage.

While used chiefly as a condiment, it is said to be beneficial in checking the perspiration of hectic fever. The gargle made as follows: Sage, 30; alum, 15; clarified honey, 60; boiling water, 500, is useful in acute pharyngitis. Sage is sometimes combined with other remedies as an injection for urethritis or cystitis.

ROSE.

ROSA GALLICA.—**Red Rose.**

Preparations.

1. **Confectio Rosæ.**—Confection of Rose.
2. **Fluidextractum Rosæ.**—Fluidextract of Rose. **Dose, 2 c.c. (30 ♏).**
3. **Mel Rosæ.**—Honey of Rose. **Dose, 4 c.c. (1 fl. dr.).**
4. **Syrupus Rosæ.**—Syrup of Rose.

OLEUM ROSÆ.—Oil of Rose. (Attar of Rose.)

Preparations.

1. **Aqua Rosæ.**—Rose Water. **Dose, 16 c.c. (4 fl. dr.).**
2. **Aqua Rosæ Fortior.**—Stronger Rose Water. **Dose, 8 c.c. (2 fl. dr.).**
3. **Unguentum Aquæ Rosæ.**—Ointment of Rose Water.

ACTION OF ROSE.

Preparations of rose are somewhat astringent, but have not much other action.

THERAPEUTICS OF ROSE.

The confection is a good base for pills, and the water an agreeable excipient for collyria, lotions and urethral injections. The ointment is a favorite soothing application for the skin. The infusion (not official: Dried petals, 2; diluted sulphuric acid, 1; water, 80), which is slightly astringent, constitutes an acceptable gargle and wash for inflamed or ulcerated conditions of the throat and mouth. Given internally it offers a pleasant method of administering sulphuric acid.

ORANGE.

AURANTII AMARI CORTEX.—Bitter Orange Peel. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Aurantii Amari.**—Fluidextract of Bitter Orange Peel. **Dose, 1 c.c. (15 ♏).**
2. **Tinctura Aurantii Amari.**—Tincture of Bitter Orange Peel. **Dose, 4 c.c. (1 fl. dr.).**

AURANTII DULCIS CORTEX.—Sweet Orange Peel. **Dose, 1 gm. (15 gr.).**

Preparation.

1. **Syrupus Aurantii.**—Syrup of Orange.
2. **Tinctura Aurantii Dulcis.**—Tincture of Sweet Orange Peel. **Dose, 4 c.c. (1 fl. dr.).**

OLEUM AURANTII CORTICIS.—Oil of Orange Peel. **Dose, 0.2 c.c. (3 ♏).**

Preparations.

1. **Spiritus Aurantii Compositus.**—Compound Spirit of Orange.
2. **Elixir Aromaticum.**—Aromatic Elixir.
3. **Elixir Adjuvans.**—Adjuvant Elixir.

Preparations of the Volatile Oil of Fresh Orange Flowers.

1. **Aqua Aurantii Florum.**—Orange Flower Water. **Dose, 16 c.c. (4 fl. dr.).**
2. **Aqua Aurantii Florum Fortior.**—Stronger Orange Flower Water. (Triple Orange Flower Water.) **Dose, 8 c.c. (2 fl. dr.).**
3. **Syrupus Aurantii Florum.**—Syrup of Orange Flowers.

ACTION OF ORANGE.

Orange is slightly bitter and aromatic, stomachic and tonic. Its oil has the action of other volatile oils. In large amounts it is a gastro-intestinal irritant and may give rise to convulsions. Persons much exposed to its fumes are liable to skin eruptions and various nervous disorders.

THERAPEUTICS OF ORANGE.

The preparations of the orange are used extensively for flavoring purposes. The aromatic and adjuvant elixirs are excellent flavoring agents and vehicles for liquid medicines.

LEMON.

LIMONIS CORTEX.—Lemon Peel.

Preparation.

Tinctura Limonis Corticis.—Tincture of Lemon Peel.

OLEUM LIMONIS.—Oil of Lemon. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF LEMON.

The same as that of orange.

THERAPEUTICS OF LEMON.

The preparations of the lemon, like those of the orange, are employed as flavoring agents. The oil may be applied externally as a rubefacient, but is seldom used for this purpose.

LIMONIS SUCCUS.—Lemon Juice. **Dose, 30 c.c. (1 fl. oz.).**

ACTION OF LEMON JUICE.

Lemon juice, which contains a considerable amount of free citric acid, has the same action as this acid (*see* pp. 302 and 313).

THERAPEUTICS OF LEMON JUICE.

Lemon juice, in the form of lemonade and various effervescing mixtures, relieves thirst and makes an otherwise refreshing beverage. Hot lemonade, to which whiskey or gin is often added, is useful as a diaphoretic in commencing colds. Lemon juice is also largely employed for flavoring flaxseed tea and the mildly nutritive drinks given in fevers. Its most important medicinal use is in the prophylaxis and treatment of scurvy, in which lemon and lime juice may almost be considered specifics. Orange juice is also efficient. The beneficial effect appears to be due, not to the citric acid, but to some unknown property of the fruit juices. 90 to 120 c.c. (3 to 4 fl. oz.) should be taken daily. A somewhat larger amount is said to have afforded marked relief in certain cases of rheumatism, both chronic and acute. Lemon juice is one of the popular remedies in this disease, though not very much reliance is probably to be placed upon it. It may be applied to the integument to relieve pruritus and to remove freckles. For sunburn an excellent lotion is made of equal parts of lemon juice and glycerin, with the addition of some bismuth subnitrate.

PEPPER.

PIPER.—Pepper. (Black Pepper.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparation.

Oleoresina Piperis.—Oleoresin of Pepper. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

PIPERINA.—Piperine. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

ACTION OF PEPPER.

By reason of its volatile oil, pepper has much the same action as cloves. In the course of its excretion it acts as a disinfectant and stimulant to the genito-urinary tract, and it is reputed to be feebly antiperiodic and antipyretic.

THERAPEUTICS OF PEPPER.

It is occasionally employed for counter-irritation, as a substitute for mustard, and, in washes and gargles, for relaxed conditions of the gums and throat. It is universally used as a condiment, and its chief medical application is to stimulate the stomach and correct flatulence. In malarial fevers the oleoresin has sometimes proved of service as an adjuvant to other remedies. Piperine has been used in cholera as a stimulant, local and general, and also in asthenic conditions of the system from various other causes.

PYRETHRUM.

PYRETHRUM.—Pyrethrum. (Pellitory.) **Dose, 2 gm.; 30 gr.**

Preparation.

Tinctura Pyrethri.—Tincture of Pyrethrum.

ACTION OF PYRETHRUM.

Pyrethrum is an irritant sialogogue. When chewed it has a prickly, pungent effect upon the mouth, tongue and fauces, and excites a free secretion of saliva and buccal mucus. It is a rubefacient and when inhaled into the nostrils causes sneezing. Internally it has the characteristic action of the volatile oils, and when taken in considerable quantities may cause gastroenteritis, with bloody stools, and more or less stupor.

THERAPEUTICS OF PYRETHRUM.

It is chewed as a masticatory in paralysis of the tongue, and when in other conditions an increased flow of saliva is desired. In neuralgic, rheumatic, or other painful affections of the tongue or teeth it may also be chewed or held in the mouth, as the burning sensation to which it at first gives rise is followed by one of numbness; the stimulation of the nerves of the parts which it causes being succeeded by depression and a blunted sensibility. For the aching of a carious tooth a few drops of the tincture may be introduced into the cavity on cotton wool. Properly diluted, it makes an efficient lotion for scorbutic and other forms of sore mouth and gargle for relaxed uvula. Pyrethrum is sometimes used as an ingredient of tooth-powders. Its sialogogue action has been found of service in the removal of iodine from the system in cases of chronic poisoning by that drug. The powder has been recommended as a sternutatory in chronic catarrh of the frontal sinuses.

CAPSICUM.

CAPSICUM.—Capsicum. (Cayenne Pepper. Guinea Pepper.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Emplastrum Capsici.**—Capsicum Plaster.
2. **Fluidextractum Capsici.**—Fluidextract of Capsicum. **Dose, 0.05 c.c. (1 ♏).**
3. **Oleoresina Capsici.**—Oleoresin of Capsicum. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**
4. **Pilulæ Podophylli, Belladonnæ et Capsici.**—Pills of Podophyllum, Belladonna and Capsicum. **Dose, 1 pill.**
5. **Tinctura Capsici.**—Tincture of Capsicum. **Dose, 0.5 c.c. (8 ♏).**

ACTION OF CAPSICUM.

Although it contains no volatile oil, the action of capsicum is like that of the volatile oils generally. It is a powerful local irritant, its oleoresin when applied to the skin producing in a short time intense pain and redness, and eventually destroying the cuticle. In the alimentary canal it acts in a similar way. In the stomach, in small doses, it occasions a feeling of warmth, excites hyperæmia, and stimulates the muscular coat and the secretions, while large doses give rise to gastro-enteritis, which after a time is accompanied by strangury and other evidences of irritation of the genito-urinary tract. Aphrodisiac effects have sometimes been noted. It is chiefly eliminated by the kidneys, and moderate amounts increase the flow of urine. It is a powerful stimulant to the heart, and thus increases the strength and frequency of the pulse.

THERAPEUTICS OF CAPSICUM.

External.—The tincture of capsicum, like that of cantharides, has been used to stimulate the scalp in the various forms of alopecia, and it is frequently employed as a domestic remedy for toothache. The diluted tincture makes a serviceable gargle in scarlet fever and for relaxed uvula, pharyngitis, and other throat affections. In tonsillitis the tincture, with an equal quantity of glycerin, may be topically applied by means of a swab. The tincture, mixed with an equal quantity of mucilage of acacia, has been recommended in chilblains (when the surface is unbroken), discolored bruises, chronic rheumatic pains, etc. The preparation is brushed two or three times upon the affected surface. Capsicum plaster is quite extensively used as a rubefacient and counter-irritant.

Internal.—Capsicum is much used as a condiment. In medicine it is an excellent remedy for flatulent colic and for cases of atony of the stomach due to general debility, errors in diet, and subacute and chronic alcoholism. In acute alcoholism it should be given with caution, if at all, as there is likely to be present more or less gastric irritation, which may be aggravated by the drug. After a few days it may usually be given with advantage, as it serves to increase the appetite and digestive power, and by its stimulating effect and the hot sensation to which it gives rise it often satisfies, at least to some degree, the craving for liquor. In these cases the tincture may be administered every four or five hours, or the oleoresin in a pill containing .06 gm. (1 gr.). In delirium tremens capsicum is often valuable in quieting restlessness and inducing sleep. It should here be given in a dose of about 2 gm. (30 gr.), which may be administered in an animal broth or made into a bolus with syrup or honey. Tincture of capsicum has been resorted to in the treatment of the opium, as well as the alcohol, habit. Capsicum tends to check albuminuria, and is therefore sometimes of service in chronic parenchymatous nephritis. It may also prove beneficial in functional torpidity of the kidney, but it is nev admissible in acute renal inflammation. In chronic pyelitis, chronic cystitis, and prostatorrhœa it is of some value, though not as efficient as cubeb. Good results may often be obtained from it in functional impotence and in spermatorrhœa from deficient tone. The oleoresin is the best preparation for use in these genito-urinary affections. Capsicum has been given as a diffusible stimulant in asthenic fevers, but is more useful in the anorexia and impaired digestion of convalescence.

GINGER.

ZINGIBER.—Ginger. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Aromaticum.** — Aromatic Fluidextract. **Dose, 1 c.c. (15 ♏).**
2. **Fluidextractum Zingiberis.** — Fluidextract of Ginger. **Dose, 1 c.c. (15 ♏).**
3. **Pulvis Aromaticus.**—Aromatic Powder. **Dose, 1 gm. (15 gr.).**
4. **Oleoresina Zingiberis.**—Oleoresin of Ginger. **Dose, 0.030 gm. = 30 milligm. (1/2 gr.).**
5. **Syrupus Zingiberis.**—Syrup of Ginger. **Dose, 16 c.c. (4 fl. dr.).**
6. **Tinctura Zingiberis.**—Tincture of Ginger. **Dose, 2 c.c. (30 ♏).**

ACTION OF GINGER.

Ginger has the same action as that of other substances containing aromatic volatile oils.

THERAPEUTICS OF GINGER.

It is much used as a stomachic, carminative, and flavoring agent. It is a favorite domestic remedy for colic, and, given in hot water, is also frequently employed as a sudorific and stimulant in the pain due to acute suppression of the menses. It is administered in association with various other remedies in the treatment of atonic dyspepsia, especially in elderly persons, and is useful in flatulence and some forms of diarrhœa. It may be given with salines to disguise their taste, and the oleoresin is a useful addition to purgative pills to prevent griping.

CARDAMOM.

CARDAMOMUM.—Cardamom. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Fluidextractum Aromaticum.**—Aromatic Fluidextract. **Dose, 1 c.c. (15 ♏).**
2. **Pulvis Aromaticus.**—Aromatic Powder. **Dose, 1 gm. (15 gr.).**
3. **Tinctura Cardamomi.**—Tincture of Cardamom. **Dose, 4 c.c. (1 fl. dr.).**
4. **Tinctura Cardamomi Composita.**—Compound Tincture of Cardamom. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF CARDAMOM.

Cardamom is carminative and stomachic, acting, by reason of its volatile oil, like cloves or pepper.

THERAPEUTICS OF CARDAMOM.

As the compound tincture has a bright red color, due to its cochineal, and an agreeable aromatic taste, it is frequently employed as a coloring and flavoring agent. It is a customary addition to mixtures given for the relief of flatulent colic, and, mixed simply with sweetened hot water, is also a favorite remedy for such affections. Cardamom makes one of the best flavoring additions to saline solutions or mixtures, and when combined with purgatives is very efficient in correcting flatulence and griping.

(*b*) Digestants.

PEPSIN.

PEPSINUM.—Pepsin. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF PEPSIN.

The only action of pepsin, which is a normal constituent of the gastric juice, appears to be on the digestive system. In the presence of hydrochloric acid it digests the proteid elements of the food, converting them into albumoses, and finally into peptones. In alkaline solution it is not only inert, but is rapidly decomposed.

THERAPEUTICS OF PEPSIN.

Pepsin is usually prescribed on the hypothesis that in certain conditions the stomach does not secrete a sufficient quantity of it. It has been questioned, however, whether this is true in even a small proportion of the cases in which this ferment is given, since the gastric juice is found to be almost always capable of digesting proteids if it is acid in reaction. In a number of forms of dyspepsia, while the acid secretion is deficient, pepsin is generally present in quantity, since it will digest proteids outside the body as soon as it becomes acid in reaction. Consequently, pepsin would seem to be indicated only in those instances in which the gastric contents acidulated with hydrochloric acid fail to perform their digestive work. Pepsin may be used as an aid to stomach digestion in those in whom from old age, continued illness, or other cause, the secretion of gastric juice is inadequate. It has been found to be more certain in its effects in the impaired digestion of infants than of adults, and this has been attributed by some, who hold that the ordinary quantities given to adults are entirely too small, to the fact that to young children it is administered in proportionately much larger doses. When it is prescribed together with alkaline carbonates, any effects produced are due entirely to the latter, the pepsin being decomposed in the presence of alkalies. It is naturally of no service in promoting the digestion of fatty or carbohydrate foods. Unless obtained from an absolutely reliable source, pepsin should be tested before giving it to a patient, as many of the specimens sold are quite inert. It should be administered, in a powder, pill or tablet, immediately after meals, and followed in about half an hour with a suitable dose of hydrochloric acid. One of the applications now made of pepsin is the predigestion by it of albuminous food, which may then be given either by the mouth or the rectum, and as morbid processes which interfere with digestion may be going on in the stomach, this method is not infrequently preferable to using the ferment in the ordinary way. As a rule, however, pancreatin is found to be of more service for purposes of predigestion than pepsin; but pepsin and pancreatin in solution should never be combined. The rectum, as is well known, has only very feeble digestive powers, and consequently nutrient enemata or suppositories should always be predigested. In the use of predigested foods, either by the mouth or rectum, much discretion should be employed, and except in case of absolute necessity the method should not be maintained for a very long period continuously, as there is some danger that the digestive functions of the stomach, from lack of use, may become incapable of action.

Meat may be peptonized in the following manner: Reduce to a fine pulp 450 gm. (1 pound) of lean meat, add six times its weight of water containing 0.2 per cent. of hydrochloric acid and 8 gm. (120 gr.) of pepsin, and digest at 48° C. (120° F.) in a porcelain digester for five or six hours, with frequent stirring; neutralize with sodium carbonate, boil and filter; evaporate the filtrate on a water-bath until it is of the consistency of a soft extract. Peptonized meat suppositories are often very serviceable. To make one suppository 2 gm. (30 gr.) of the above extract is mixed with 2.40 gm. (40 gr.) of oil of theobroma, and shaped in a conical mould.

PANCREATIN.

PANCREATINUM.—Pancreatin. (Zymine.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Unofficial Preparation.

Trypsinum.—Trypsin.

Action of Pancreatin.

Pancreatin, in the presence of alkalies, has the power of digesting albuminoids and all proteid substances (which are changed to peptones), of converting starch into sugar, and of emulsionizing fats. It coagulates and then peptonizes milk, and will also peptonize gruel and many other articles of diet. It is incapable of acting in an acid medium, or in a temperature above 60° C. (140° F.).

Therapeutics of Pancreatin.

It is used as an artificial agent to assist the digestion of valids and of old persons, or those prostrated by fever haustion. Also by means of it food may be partially or wholly digested previous to administration. It should be used in combination with an alkali, as sodium bicarbonate, in the proportion of 1 to 4. Nutritive enemata should be thoroughly pancreatized. If pancreatin be administered two hours after meals it will assist intestinal digestion, and it is especially indicated in those conditions in which starch and fat are imperfectly digested. It should be preceded by full doses of sodium bicarbonate, or other alkali, to insure an alkaline reaction in the contents of the stomach. It is sometimes of service in the vomiting of pregnancy or of hysteria. In diphtheria a spray of trypsin (the proteolytic ferment of pancreatin) or of pancreatin solution has been used with considerable success for the purpose of dissolving the false membrane and promoting its expulsion. Pancreatin has also been employed in the bladder, like pepsin, to dissolve blood-clots resulting from hæmorrhage. It should never be used in solution with pepsin. Of late trypsin has been brought forward as an alleged successful agent in the treatment of cancer, and much concerning it in this light, pro and con, has been written in the medical journals. The present state of opinion in regard to the matter cannot perhaps be better stated than in the following conclusions of a recent investigator: A discreet cancerous node systematically attacked by injections of trypsin shrinks and becomes hard and fibrous, or disappears; neighboring nodes are little, if at all, affected, and are probably influenced only when the agent comes into actual contact with the growing cells; the reduction or disappearance of a given node does not prevent the appearance later of another node in immediate proximity to it; evidence is lacking to show that trypsin affects cancer cells by circulating in the blood, or in any other way than by direct contact; while the internal administration of the various pancreatic ferments is of benefit to cachectic patients, such benefit would appear to be due simply to the assistance given to the intestinal digestive secretions; the direct action of trypsin on growing cancer cells, as shown clinically and microscopically, is sufficient warrant to continue the treatment in inoperable cases.

(*c*) **Carminatives.**

Many drugs already considered among the stomachics are also carminatives.

VALERIAN.

VALERIANA.—Valerian. **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Fluidextractum Valerianæ.**—Fluidextract of Valerian. **Dose, 2 c.c. (30 ♏).**
2. **Tincture Valerianæ.**—Tincture of Valerian. **Dose, 4 c.c. (1 fl. dr.).**
3. **Tinctura Valerianæ Ammoniata.**—Ammoniated Tincture of Valerian. **Dose, 2 c.c. (30 ♏).**

AMMONII VALERAS.—Ammonium Valerate. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ZINCI VALERAS.—Zinc Valerate. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF VALERIAN AND THE VALERATES.

Valerian acts in virtue of its volatile oil, which has the same properties as other volatile oils. Valerian is therefore an **irritant** when applied externally, causing redness, itching and warmth by reason of the local dilatation of vessels which it induces. Internally it stimulates the mouth (leading to a reflex secretion of saliva) and the gastro-intestinal tract. It causes increased appetite and in the stomach a sense of warmth and comfort, with reflex stimulation of the heart and nervous system. The slight irritation produces hyperæmia of the mucous membrane, with some increase of secretion, and the movements of the stomach are accelerated. Similar effects are observed in the intestine. While nervous effects are produced reflexly by the local action, sufficient doses affect the central nervous system independently of such local action. There is a preliminary stimulation followed by a depression of the nerve-cells, and the higher
sions of the central axis are more markedly acte
the lower. Excretion takes place principally
kidneys, and in the course of this action

increased secretion may be induced in these organs. The heart is stimulated indirectly, but does not seem to be affected except in this indirect manner. It has been found that in cases of poisoning by the volatile oil the collapse and shock may alter the cardiac contractions, but direct effects on the cardiac muscle, it is stated, have not been shown to be produced, unless when enormous quantities are injected intravenously. Under large doses by the mouth, nausea, hiccough, eructations of the drug, vomiting and diarrhœa may be caused.

THERAPEUTICS OF VALERIAN AND THE VALERATES.

Valerian in various forms is much used as a carminative for the relief of flatulence, especially in hysterical conditions. Any feeling of fullness after meals is removed, and this is often accompanied by the eructation of quantities of gas. Though the oil is not official, it is more efficient as a carminative than the valerates. It is most conveniently administered suspended in mucilage with cinnamon water. The tincture and fluidextract also usually promptly relieve the flatulence of the hysterical and hypochondriacal. Preparations of valerian are likewise serviceable as reflex stimulants in syncope, palpitation, etc., and their chief therapeutic use is in the treatment of nervousness, hysteria and hysterical disorders generally. In these, ammonium valerate is preferred by many. In neuralgic conditions they sometimes prove of value, and again fail to give relief. As a rule, the best preparation here is zinc valerate, which has also been employed with some success in nervous affections such as chorea and epilepsy. In both forms of diabetes the fluidextract has been used temporarily with advantage. It serves to diminish the amount of urinary water, and in the saccharine variety to lessen the excretion of sugar. It has no curative effect, however, for as soon as the remedy is discontinued all benefit from it ceases.

CYPRIPEDIUM.

CYPRIPEDIUM.—Cypripedium. (Ladies' Slipper.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Cypripedii.—Fluidextract of Cypripedium. **Dose, 1 c.c. (15 ♏).**

ACTION OF CYPRIPEDIUM.

Cypripedium is a mild nervous stimulant, resembling valerian in its action.

THERAPEUTICS OF CYPRIPEDIUM.

It has been used for nervous diseases, epilepsy, hypochondriasis and neuralgia, but is not a very reliable remedy.

ASAFETIDA.

ASAFŒTIDA.—Asafetida. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Emulsum Asafœtidæ.**—Emulsion of Asafetida. (Milk of Asafetida.) **Dose, 16 c.c. (4 fl. dr.).**
2. **Pilulæ Asafœtidæ.**—Pills of Asafetida. **Dose, 2 pills.**
3. **Tinctura Asafœtidæ.**—Tincture of Asafetida. **Dose, 1 c.c. (15 ♏).**

ACTION OF ASAFETIDA.

Owing to its containing allyl sulphide, asafetida is extremely unpleasant to the taste. Its action is due entirely to its volatile oil, the external and internal effects of which are those of the volatile oils in general. On the intestine it has a specially marked **stimulant** action, expelling flatus and producing an efficient carminative effect. Large doses may cause nausea and vomiting, though the action of the drug varies greatly in different individuals. A series of experiments showed that in a number of persons headache and giddiness, with some aphrodisiac effect, were produced by 1.20 gm. (20 gr.), while others took as much as 15 gm. (½ oz.) with no other result than offensive eructations and foul-smelling fæces. It often has a powerful stimulant and antispasmodic effect upon the nervous system, and there is reason to believe that in hysterical subjects this is in part at least due to the mental influence resulting from the odor and taste of the drug. In some women an emmenagogue effect has been noticed from it. It is excreted by the lungs, skin and kidneys, and is found to act like other volatile oils in increasing and disinfecting the secretions.

Therapeutics of Asafetida.

Were it not for the extremely disagreeable eructations to which it gives rise, asafetida might prove very useful as a stomachic tonic in atonic dyspepsia accompanied by torpor of the bowel. It is contained in small amount in some of the popular sauces. The emulsion was long held in high repute in the flatulent colic of infants, and is still used to some extent, though most practitioners prefer to give remedies less obnoxious to the attendants, if not to the little patients themselves. Asafetida is especially serviceable in the flatulence of neurotic subjects, expelling the flatus, promoting intestinal secretion and digestion, and relaxing the bowels; and it is commonly very well borne by this class of individuals Partly on account of its reflex stimulating effect, and partly on account of the moral effect of its offensive odor and taste, this remedy is not infrequently employed to control hysterical, emotional and other mental disturbances, and for this purpose it is sometimes combined with valerian. Although asafetida, in the course of its excretion, would serve a useful purpose in disinfecting the urine and the expectoration, its disagreeableness ordinarily prevents its use for these purposes. Still, it is occasionally employed in subacute bronchitis and bronchorrhœa (especially in old people), the cough succeeding the paroxysmal stage of pertussis (which is often maintained by habit), and the sympathetic cough of mothers whose children are suffering from whooping-cough; all of which conditions are found to be greatly benefited by it. This remedy is of service in the convulsions of children from reflex irritation, though it is useless in those depending upon cerebral or renal disease; and may also be given with advantage in chorea, particularly in young girls about the period of puberty and when the affection is associated with menstrual difficulty. One method of curing malingering is to make the patient take, three times a day, an effervescing draught containing a few drops of the tinctures of asafetida and valerian; the effervescence causing the unpleasant taste of the medicines to recur in the mouth for some time after they have been swallowed.

MYRRH.

MYRRHA.—Myrrh. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Mistura Ferri Composita.** — Compound Iron Mixture. **Dose, 16 c.c. (4 fl. dr.).**
2. **Pilulæ Aloes et Myrrhæ.**—Pills of Aloes and Myrrh. **Dose, 2 pills.**
3. **Tinctura Aloes et Myrrhæ.**—Tincture of Aloes and Myrrh. **Dose, 2 c.c. (30 ♏).**
4. **Tinctura Myrrhæ.**—Tincture of Myrrh. **Dose, 1 c.c. (15 ♏).**

ACTION OF MYRRH.

External.—Locally applied it is mildly irritant to the skin and stimulant and disinfectant to mucous membranes and ulcerated surfaces.

Internal.—Its internal, as well as its external, effects are due to its volatile oil. In moderate doses it is **carminative,** stimulant and tonic, and in large doses a **gastro-intestinal irritant,** exciting vomiting and purging. It is excreted by mucous membranes, especially the bronchial and the genito-urinary, and it is believed to increase the number of leucocytes in the blood. It has expectorant qualities and is also reputed to be a stimulant to the ovarian and uterine functions.

THERAPEUTICS OF MYRRH.

External.—The tincture is sometimes used for the removal of freckles, and an ointment containing myrrh may be applied as a stimulant and antiseptic dressing to indolent or unhealthy ulcers. In cases of eczema requiring moderate stimulation an ointment made by heating together myrrh with wax and oils has been found useful. The undiluted tincture may be applied to ulcerated gums, aphthous patches, and relaxed uvula. Diffused in water (1 to 16), with the addition of a little phenol or thymol, the tincture is a good mouthwash for spongy gums, for mercurial ptyalism, or for wound
after operations upon the mouth, and may als
gargle in pharyngitis, etc. As a mouth-w

monly associated with borax, as in the following formula: Myrrh, 1; Cologne water, 16; borax, 1; water, 3; syrup, 3. Myrrh has long been employed as an ingredient of dentifrices.

Internal.—Its internal administration is considered of service in checking excessive discharges: bronchorrhœa, leucorrhœa, cystitis, etc. Myrrh is frequently prescribed with purgatives on account of its carminative and stomachic properties, and, in combination with other remedies, is more or less employed in atonic dyspepsia and gastralgia. It is considered more especially useful in such conditions when they are associated with flatulence, mucous evacuations, constipation, and the presence of nervous disorders of a hysterical or hypochondriacal character. Here it may profitably be combined with vegetable bitters and iron. The compound iron mixture, in which myrrh is one of the chief constituents, is quite extensively used in amenorrhœa connected with anæmia and general torpor of the system. It has been doubted by some whether myrrh really has any effect on the menstrual function, its apparent value in amenorrhœa being due, it is alleged, to the iron, aloes, or other drugs usually combined with it. It has remained in use as an emmenagogue, however, for a very long time, and in this capacity still seems to retain the confidence of the profession.

(*d*) Gastric Sedatives.

BISMUTH.

1. **BISMUTHI CITRAS.**—Bismuth Citrate. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

2. **BISMUTHI ET AMMONII CITRAS.**—Bismuth and Ammonium Citrate. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

3. **BISMUTHI SUBCARBONAS.**—Bismuth Subcarbonate. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

4. **BISMUTHI SUBGALLAS.**—Bismuth Subgallate. (Dermatol.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

5. **BISMUTHI SUBNITRAS.**—Bismuth Subnitrate. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

6. **BISMUTHI SUBSALICYLAS.**—Bismuth Subsalicylate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Unofficial Preparations.

Bismuthi Naphtholas.—Bismuth Naphtholate. (Beta-Naphthol Bismuth.) **Dose, .30 to 2.00 gm.; 5 to 30 gr.**

Bismuthi Phenolas.—Bismuth Phenolate. (Phenol-Bismuth.) **Dose, .30 to 2.00 gm.; 5 to 30 gr.**

Bismuthi Tribromophenolas. — Bismuth Tribromophenolate. (Tribromophenol-Bismuth. Xeroform.) **Dose, .30 to 2.00 gm.; 5 to 30 gr.**

ACTION OF BISMUTH SALTS.

External.—Bismuth salts have no action on the unbroken skin. On abraded surfaces they are **antiseptic** and **mildly astringent.** When dusted on such a surface they form a protecting coat over it. Used in this way their value, as in the case of iodoform, probably depends not so much on their germicidal action as on their absorption of the fluids of the part, which renders the surface less favorable for the growth of bacteria.

Internal.—When injected in large quantities directly into the circulation, bismuth salts produce, like arsenic, a relaxation of the walls of the capillaries, and it is believed that they have a direct action on the central nervous system and depress the vaso-motor centre in the medulla. There is also a depressant action on the cardiac muscle, and from both these influences the blood-pressure falls rapidly. Late in the poisoning the heart is often found to stop entirely for some time, and then suddenly resume its action. The respiration is at first quickened, and violent convulsions, both clonic and tonic, follow at short intervals, during which the movements are feeble and incoördinated. In some animals the respiration ceases before the heart, and in others the reverse of this is noted. The injection of smaller quantities is followed by more chronic effects, which resemble those met with in cases of poisoning in the human subject. In man medicinal doses of the insoluble salts, although maintained for a long period, produce very few appreciable symptoms. Any action which they may have in increasing peristalsis and the secretion of mucus in the stomach is probably simply that which would be caused by the presence of any heavy powder. In the intestine they are said to have some effect in augmenting the leucocytes of the blood, and they are apt to induce more or less constipation. The stools are blackened, a result which is generally supposed to be due to the formation in the large intestine of bismuth sulphide, but which is attributed by some to the reduction of bismuth in the bowel. Occasionally a purplish line makes its appearance on the gums. As long as bismuth was employed only internally, no serious effects were produced by its insoluble salts, as it is now known that certain cases of poisoning formerly ascribed to them were in reality due to the arsenic, lead or antimony with which they were contaminated. Since their use was extended to the treatment of wounds and abraded surfaces, however, several instances of dangerous intoxication have been observed, though the patients have generally recovered when the bismuth dressing was removed. Among the symptoms which have been noted may be mentioned black spots, or even gangrene, in the mouth and fauces, swelling of the gums, tongue and throat, increased flow of saliva, dysphagia, nausea, vomiting, diarrhœa and albuminuria. As much less bismuth is used for external applications than is often given by the mouth, it would appear either that the drug is more readily absorbed from raw surfaces than from mucous membranes or else that what is absorbed from the alimentary canal is prevented by the liver from reaching the general circulation. In animals in which chronic poisoning is induced by the intravenous or subcutaneous injection of moderate amounts of bismuth salts there are caused salivation, ulcerative stomatitis, gastro-intestinal irritation, muscular weakness and incoördination, and usually tetanic convulsions at intervals, while the urine contains albumin and casts. The blood-pressure is low, as a result of the intestinal disturbance and general collapse, and complete paralysis eventually results. Post-mortem there are found ulcerations of the mouth and gums and of the large intestine, and inflammation and necrosis of the kidneys. There is also an intense black pigmentation of the upper part of the large intestine, which is limited very exactly by the ileo-cæcal valve and which extends throughout the thickness of the bowel-wall. This is caused by the depositing of bismuth sulphide on the mucous membrane and in the capillary vessels and lymph spaces, and the ulceration found is no doubt due to the embolism which results from this precipitation in the vessels. Bismuth is excreted all along the alimentary canal, but particularly in the large intestine, and also by the urine and possibly by the milk; and is stored in considerable amount in the liver. In therapeutic doses bismuth salts, especially the naphtholate act as **antiseptics**, and it is believed that the benefit derived from them is also due to some extent to their ridding the intestinal canal of hydrogen sulphide, in consequence of the avidity of bismuth for this irritant compound.

Therapeutics of Bismuth Salts.

External.—Bismuth salts are useful as dusting powders for ulcers and excoriated surfaces and as a dressing for wounds, when not too large. For such purposes the tribromophenolate and subgallate are preferable. The subnitrate and subcarbonate are also employed to some extent. In acne, vesicular eczema, intertrigo and the erythema of infants one of these salts may be lightly dusted over the surface. Bismuth compounds are also used in ointments, and the following will be found serviceable: Bismuth oxide (not official), 1 part, and oleic acid, 8 parts, stirred in with 3 parts of white wax liquefied by heat, and with 9 parts of soft paraffin. The subnitrate, snuffed into the nostrils, is sometimes employed in coryza and simple ozæna and as a topical application in aphthous or nursing sore mouth, mercurial ptyalism, chronic conjunctivitis and granular lids. An ointment composed of bismuth subnitrate, boric acid, lanolin and olive oil has been found especially suited to the treatment of burns in children. The subnitrate, suspended in mucilage, may be used as an injection for gonorrhœa or leucorrhœa. It may also be applied in the form of soluble bougies and suppositories, and preparations of this kind are of service for ulcers of the rectum.

Internal.—Bismuth salts are used internally chiefly for their local action upon the alimentary tract, as they form a protective coating over the irritated or inflamed surfaces and keep them from coming in contact, and also exert an
sedative and antiseptic influence. The ones

quently prescribed are the subnitrate and subcarbonate, which are safer and also appear to be more efficient than the soluble salts. The latter when absorbed are likely to act as irritant poisons, and for this reason should not be used. The insoluble compounds are best given suspended in mucilage, which should be made with tragacanth, for when acacia is used a compact mass is formed. However they may effect these results, bismuth preparations are very efficacious in relieving gastric pain, whether due to organic disease, such as scirrhus, or to less serious causes, and also not infrequently in checking vomiting of whatever origin. They are said not to be beneficial in the gastralgia of chlorosis and hypochondriasis, nor in that produced by habitual constipation. In the latter condition they are naturally contra-indicated on account of their astringent effects. They are of great service in both acute and chronic gastritis, and also in gastric ulcer, where they not only alleviate the pain but contribute to the cure of the condition. In these painful affections their good effects are increased by having morphine combined with them.

Sodium bicarbonate also often enhances their effects as gastric sedatives, but it should not be prescribed in a mixture with bismuth subcarbonate, as the formation of carbon dioxide is likely to result. Bismuth salts are useful likewise in the treatment of diarrhœa of various kinds. They are generally most efficient when given in large doses, and this is especially true in that of tuberculosis and in chronic diarrhœa. For internal use the phenolate and naphtholate are preferable to the inorganic salts. The subsalicylate is also a very useful preparation. It probably passes through the stomach unchanged, to be broken up in the small intestine, where it acts as an unirritating antiseptic. It has been proved to be a valuable remedy in the treatment of diarrhœas, typhoid fever, and catarrhs of the alimentary tract. Reliable observations in Asiatic cholera prove that the tribromophenolate is a valuable intestinal antiseptic. Bismuth subgallate was formerly much employed in the treatment of gastro-intestinal indigestion, but has been largely supplanted by the more efficient naphtholate and tribromophenolate.

TOXICOLOGY.

When applied in large quantity to an exterior wounded surface sufficient bismuth may be absorbed to produce poisoning. This may also occur if glycerin is used to form an emulsion for injection into closed cavities (abscesses, joint-disease).

Symptoms.—These are, acute stomatitis with a peculiar blackish discoloration of the mucous membrane, generally upon the borders of the teeth and extending over the whole mouth, ulceration of the mucous membrane, intestinal catarrh, pain and diarrhœa. Even desquamative nephritis may be set up.

Treatment.—Use demulcents.

CERIUM.

CERII OXALAS.—Cerium Oxalate. (Cerous Oxalate.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

ACTION OF CERIUM OXALATE.

Very little is known of the effects of cerium oxalate, but when injected into the circulation it is said to produce gastro-intestinal irritation, with vomiting and diarrhœa and hyperæmia and ecchymoses of the mucous membranes, and also congestion or inflammation of the kidneys. It seems to be absorbed with difficulty from the stomach and bowel.

THERAPEUTICS OF CERIUM OXALATE.

It is used empirically as an anti-emetic, and especially for the vomiting from pregnancy, seasickness and other conditions in which gastric irritation is not the primary cause. It is not known how it acts in controlling emesis, but it is thought probable that its effects are local and similar to those of bismuth subnitrate. The dose above given is often exceeded; 2 gm. (30 gr.) have been frequently given with good results. Cerium oxalate appears to have some action as a sedative to the gastric mucous membrane, and so may allay the pain of gastralgia or prove beneficial in dyspepsia occasioned by deranged innervation. In cases of cough (no doubt of reflex origin) associated with vomiting, it is sometimes of great service, and it has even been recommended for controlling excessive cough in phthisis or chronic bronchitis. In chronic diarrhœa it may be used in the place of bismuth.

D. DRUGS ACTING ON THE INTESTINES.

(*a*) Laxatives.

HONEY.

MEL.—Honey.

Preparations.

Mel Depuratum.—Clarified Honey.
Mel Rosæ.—Honey of Rose. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF HONEY.

Honey is demulcent, nutritive and slightly laxative. Generally it constitutes an agreeable article of diet. In some individuals, however, it causes pyrosis, flatulence and colic, and in others an eruption of urticaria.

THERAPEUTICS OF HONEY.

Honey is useful in relieving dryness of the mouth and facilitating swallowing, and oxymel (clarified honey, 8; acetic acid, 1; water, 1) is a pleasant addition to gargles or vehicle for astringents or expectorants. Honey is sometimes a sufficient laxative for the constipation of children.

TAMARIND.

TAMARINDUS.—Tamarind. **Dose, 16 gm. (240 gr.).**

Preparation.

Confectio Sennæ.—Confection of Senna. **Dose, 4 gm. (60 gr.).**

ACTION OF TAMARIND.

Tamarind is nutritive, laxative and refrigerant.

THERAPEUTICS OF TAMARIND.

It may be given to fever patients or convalescents in the form of tamarind whey (1 part of tamarind to 30 of milk) as an acid, cooling, slightly purgative drink. As a laxative it is often prescribed in association with other remedies, but in the case of children it may be given alone, spread upon bread and butter.

FIG.

FICUS.—Fig.

Preparation.

Confectio Sennæ.—Confection of Senna. **Dose, 4 gm. (60 gr.).**

ACTION OF FIG.

Fig is a pleasant and mildly purgative article of diet. The mucilaginous and saccharine constituents of the fresh fruit give it a laxative action. This effect in dried fig is largely due to the indigestible skins and seeds, which act mechanically in stimulating intestinal paralysis, but also have some tendency to create flatulence.

THERAPEUTICS OF FIG.

It may be used as a dessert to correct slight constipation, and confection of senna is a very serviceable laxative for children. Poultices made with the dried fruit and milk have sometimes been found by surgeons to neutralize the most persistent fetor of cancerous and other ulcers.

PRUNE.

PRUNUM.—Prune.

Preparation.

Confectio Sennæ.—Confection of Senna. **Dose, 4 gm. (60 gr.).**

ACTION OF PRUNE.

Prune is demulcent, nutritive and slightly laxative.

THERAPEUTICS OF PRUNE.

It may be eaten, either raw or stewed, as an article of diet in cases of slight constipation. In "medicated prune" senna or podophyllin is added to give a more pronounced purgative effect.

MANNA.

MANNA.—Manna. **Dose, 16 gm. (240 gr.).**

ACTION OF MANNA.

Manna is aperient when taken in considerabl

THERAPEUTICS OF MANNA.

It is given as a mild laxative to children. It dissolves easily in milk, and is pleasant to the taste.

CASSIA FISTULA.

CASSIA FISTULA.—Cassia Fistula. (Purging Cassia.) **Dose, 4 gm. (60 gr.).**

Preparation.

Confectio Sennæ.—Confection of Senna. **Dose, 4 gm. (60 gr.).**

ACTION OF CASSIA FISTULA.

Cassia is laxative and, in quantities sufficient to purge, causes nausea, flatulence and griping.

THERAPEUTICS OF CASSIA FISTULA.

It is administered as one of the ingredients of confection of senna, but in this country is rarely ever prescribed in any other form.

CASTOR OIL.

OLEUM RICINI.—Castor Oil. **Dose, 16 c.c. (4 fl. dr.).**

ACTION OF CASTOR OIL.

External.—Castor oil, like other bland fixed oils, is protective and sedative when applied to the skin and mucous membranes.

Internal. *Gastro-intestinal Tract.*—The so-called unpleasant taste of castor oil is mostly due to the smell, and if the nose is held when the oil is swallowed, it is less disagreeable. It is not irritant to the stomach, upon which it produces no effects. When it reaches the intestine, however, it is decomposed by the digestive juices, and the ricinoleates thus formed are irritant and cause purgation. Castor oil may be taken in very large quantities without producing any other effect than that of a simple laxative. The seeds of the Ricinus communis contain an intensely poisonous toxalbumin, ***Ricin,*** which was at one time supposed to be the active principle of the oil, but it is now known that the latter is entirely free from this substance, and that its action is solely due to the ricinoleic acid of which it is the glyceride. A similar but less poisonous toxalbumin is found in the seeds of the Croton Tiglium, but does not enter into the composition of croton oil itself. It takes about five hours for castor oil to operate, the stools from it being soft, but not liquid, and it does not usually cause griping. Even when rubbed into the skin, it is capable of acting on the bowels, and also when thrown into the rectum. It is absorbed from the intestine and disappears in the tissues like ordinary oils. A single dose is not followed by constipation, but this is very apt to result from the habitual use of the drug. The symptoms of poisoning by castor beans are violent abdominal pain, vomiting and purging, with collapse, and in fatal cases evidences of severe gastro-enteritis have been found *post mortem.*

THERAPEUTICS OF CASTOR OIL.

On account of the mildness of its action, castor oil is one of the most useful drugs we have in cases where it is desired simply to evacuate the alimentary canal. For instance, it is well adapted for getting rid of undigested food that is causing diarrhœa. When irritating substances or hardened fæces are to be removed from the intestines it is the most efficient purgative compatible with safety. Formerly it was advised, as a routine practice, to give a dose of castor oil early on the morning of the third day after parturition, for the purpose of modifying the severity of the so-called milk-fever. Since the general introduction of the thermometer into practice, however, and the better understanding of the causes of febrile temperatures in the puerperal state, the existence of a distinct milk-fever referable to functional disturbance in the breasts during the period in question has been found to be an entirely exceptional occurrence. Still, although the administration of this particular laxative at this time has largely fallen into disuse, the canonical practice of opening the patient's bowels on the third day is of unquestionable utility, for the reason that very few women escape from an accumulation of fæcal matter (which is often very great) during the last weeks of pregnancy. In some an ordinary injection of soap and olive oil in water suffic
an adequate evacuation; in others, comp

compound rhubarb pill, or a dose of some cathartic mineral water. In obstinate cases a calomel purge may be called for. A very favorite post-partum combination is a pill composed of compound extract of colocynth, extract of hyoscyamus, powdered aloes, and extract of nux vomica, with a small quantity of podophyllin and ipecacuanha. By some of the best obstetricians castor oil is now given only in cases of severe colic, in which it is sometimes found advisable to combine with it a small dose of laudanum. When inflamed hæmorrhoids, fissures of the anus or surgical operations on the pelvic viscera require the use of a certain, but mild and unirritating, laxative, castor oil should be selected. It is often very useful in the temporary constipation of children, as well as in diarrhœa in young subjects induced and maintained by undigested food or irritating secretions. In the latter condition the oil may be followed with advantage by an opiate or an enema containing laudanum, and in some forms of diarrhœa, both in adults and children, a small quantity of laudanum is frequently administered with it. In the dysentery of children and the sporadic dysentery of adults, especially after the more acute febrile symptoms have subsided, an emulsion of castor oil made with mucilage of acacia (to which laudanum or paregoric may be added if the symptoms are severe), is generally of great service. It may also prove valuable in the entero-colitis of infants and young children. In these cases the amount of oil in each dose should be quite small. Except in the case of aspidium (*see* Aspidium), castor oil is a good purgative to give before and after the use of anthelmintics. It is not suited for cases of chronic constipation. As an enema it does not appear to possess any advantages over olive oil. One part of castor thoroughly mixed with five parts of warm olive oil may be used for a mild injection.

As most persons object to taking castor oil by itself, it is generally necessary to disguise its taste in some way. It may be given in soft capsules, which can be obtained of any desired size. If for any reason these are objectionable, it is best administered in the beverage known as sarsaparilla. Lemon juice or coffee conceals the taste to some extent, and the following is recommended as a good way in which to take it: The oil is added to 4 c.c. (1 fl. dr.) of peppermint water, and then a little brandy added till the oil neither sinks nor floats. If the inside and rim of the glass are moistened with the vehicle, the oil, which should, if possible, be between two layers of the vehicle, is scarcely tasted. In the same way it may be taken in the froth of ale or beer. The extemporaneous dose prepared at the soda-water fountain is preferred by many persons. Castor oil with balsam of Peru (*see* Balsam of Peru) makes an excellent surgical dressing which is applicable for burns, wounds, abscesses, and many other conditions, and the oil is occasionally used as a basis for ointments for the treatment of alopecia. A drop of the oil in the eye will often relieve the irritation caused by a foreign body or by granular lids. A poultice made of the leaves of the castor-oil plant (not official) may be applied to the breasts to promote the secretion of milk.

(*b*) Simple Purgatives.

ALOES.

ALOE.—Aloes. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Aloe Purificata.**—Purified Aloes. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Extractum Aloes.**—Extract of Aloes. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**
3. **Pilulæ Aloes.**—Pills of Aloes. **Dose, 2 pills.**
4. **Pilulæ Aloes et Ferri.**—Pills of Aloes and Iron. **Dose, 2 pills.**
5. **Pilulæ Aloes et Mastiches.**—Pills of Aloes and Mastic. (Lady Webster's pill.) **Dose, 2 pills.**
6. **Pilulæ Aloes et Myrrhæ.**—Pills of Aloes and Myrrh. **Dose, 2 pills.**
7. **Tinctura Aloes.**—Tincture of Aloes. **Dose, 2 c.c. (30 ♏).**
8. **Tinctura Aloes et Myrrhæ.**—Tincture of Aloes and Myrrh. **Dose, 2 c.c. (30 ♏).**

ALOINUM.—Aloin. **Dose, 0.015 gm. = 15 milligm. (1/4 gr.).**

Preparation.

Pilulæ Laxativæ Composit
Dose, 2 pills.

ACTION OF ALOES.

External.—Aloes has no action on the unbroken skin, but is thought to be slightly stimulating to denuded surfaces. Powdered aloes, dusted upon an abrasion, blister or ulcer, is capable of being absorbed and producing the characteristic internal effects of the drug.

Internal. *Gastro-intestinal Tract.*—Like other substances having a strong bitter taste, aloes, in small doses, acts as a stomachic. It is a slowly acting but efficient cathartic. Its main action is shown in the **stimulation** of the **large intestine,** particularly the rectum, and the result of this is chiefly muscular contraction, though some increase of secretion is also produced by it. The presence of bile in the intestine is necessary to elicit its full effects, and it is believed itself to cause some **increased secretion of bile,** as indicated by the dark character of the passages from it. If given alone it usually causes a considerable amount of griping pain. Aloin is regarded as less certain in its purgative action than aloes, and there can be little question, it is thought, that the crystalline aloin itself is inactive in the bowel, but is there changed under certain conditions to an amorphous compound which has irritant effects. It is stated, however, that a warm solution of aloin will produce purgation if injected subcutaneously.

Pelvic Organs.—Aloes produce a comparatively marked congestion of the pelvic organs, and is therefore regarded as an **emmenagogue.**

Excretion.—It is readily absorbed, and is eliminated through the bowels and kidneys, and also in the milk. It is quite likely that the habitual use of the drug will result in irritation of the kidneys.

THERAPEUTICS OF ALOES.

As it usually requires from twelve to fifteen hours, or more, to act on the bowels, it is customary to administer it comparatively early in the evening in order to secure a movement from it in convenient season on the following morning. On account of the griping which it is apt to cause if employed alone, it is usually associated with carminatives or other agents calculated to promote greater regularity of peristaltic contraction. A

small amount of extract of hyoscyamus or extract of belladonna generally answers very well. The bitter principles of aloes are of service in aiding digestion, and a very good dinner pill is composed of .06 gm. (1 gr.) of extract of aloes and .015 gm. (¼ gr.) of extract of nux vomica. If the fæces are hard, .03 gm. (½ gr.) of powdered ipecacuanha should be added. Such a pill, with the addition of .06 or .12 gm. (1 to 2 gr.) of ferrous sulphate is often very useful in anæmia. For chronic constipation, especially in children and also in persons of middle age, many of which are due to an imperfect contraction of the muscular coat of the large intestine, aloes is an excellent purgative. If given in moderate doses, it has the advantage of not producing subsequent constipation, and, in addition, of seldom requiring an increase in the dose. Simple jaundice, of an atonic kind, and jaundice, or at least a bilious state, in which the tongue is coated, the breath foul, the abdomen tumid, and the colon impacted, may usually be successfully treated with this remedy. The constipation of hypochondriasis and melancholia also is best overcome by the use of aloes, and, with the removal of the impacted fæces, there is not infrequently an improvement in the mental state. In cerebral disorders when purgatives are indicated for their derivative effect, this is the one commonly selected. In cases of hysteria, with anæmia and constipation, it may be combined with asafetida, which has also a carminative effect. Combined with iron and asafetida or myrrh, aloes is used to a considerable extent in the treatment of amenorrhœa, whether associated with chlorosis or not. Although it is generally believed to induce hyperæmia of the pelvic organs, it seems quite possible that the relief by it of the constipation which is so commonly present in these cases is largely, if not chiefly, responsible for the improvement which frequently takes place under its use. It is often stated that aloes is contraindicated in cases of menorrhagia. This is no doubt true as regards full-blooded subjects, but when this condition occurs in the debilitated and relaxed, it is sometimes relieved by the drug. As to the risk of employing it in pregnancy, l
of the uterine vessels induced by it may

has also been suggested by writers, it would appear doubtful whether the danger from aloes in this respect is greater than that from any other active cathartic. The presence of hæmorrhoids has been regarded as another contra-indication, but if a patient suffers from hæmorrhoids which are not inflamed, aloes can be safely administered, and even with marked benefit if they are due to a relaxed rectal mucous membrane. The following enema may be given for ascarides: Aloes, 8; potassium carbonate, 3; mucilage of starch, 960. As the purgative principle of aloes is excreted to some extent in the milk, the drug should be avoided or given with great caution in the case of nursing women, on account of the danger of its causing diarrhœa in the infant.

RHUBARB.

RHEUM.—Rhubarb. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Extractum Rhei.**—Extract of Rhubarb. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Fluidextractum Rhei.**—Fluidextract of Rhubarb. **Dose, 1 c.c. (15 ♏).**
3. **Mistura Rhei et Sodæ.**—Mixture of Rhubarb and Soda. **Dose, 4 c.c. (1 fl. dr.).**
4. **Pilulæ Rhei Compositæ.**—Compound Pills of Rhubarb. **Dose, 2 pills.**
5. **Pulvis Rhei Compositus.**—Compound Powder of Rhubarb. **Dose, 2 gm. (30 gr.).**
6. **Syrupus Rhei.**—Syrup of Rhubarb. **Dose, 8 c.c. (2 fl. dr.).**
7. **Syrupus Rhei Aromaticus.**—Aromatic Syrup of Rhubarb. (Spiced Syrup of Rhubarb.) **Dose, 8 c.c. (2 fl. dr.).**
8. **Tinctura Rhei.**—Tincture of Rhubarb. **Dose, 4 c.c. (1 fl. dr.).**
9. **Tinctura Rhei Aromatica.**—Aromatic Tincture of Rhubarb. **Dose, 2 c.c. (30 ♏).**

ACTION OF RHUBARB.

External.—Rhubarb is never used for external application. If it were so applied, it would probably give rise to a mild irritation in consequence of its chrysarobin, which by itself excites inflammation of the skin.

Internal. *Alimentary Canal.*—In the mouth, rhubarb slightly increases the salivary secretion. In moderate doses it is **stomachic,** by reason of its bitter resins, increasing gastric secretion, peristalsis, vascularity and absorption, and thus promoting digestion. In larger doses it has a **purgative** action, producing in from four to eight hours, generally with some griping, a soft, though not watery, evacuation which is of a yellowish-brown color, due to the chrysarobin. The purgative properties of the drug have been attributed to the chrysarobin, although, chrysophanic acid, which it yields, is stated not to cause purgation, on account of its rapid absorption. Rhubarb has some effect in increasing the biliary secretion, but its cholagogue action is not sufficiently marked to entirely explain its purgative properties. It probably also increases the excretion of bile by accelerating its passage through the intestine and preventing its reabsorption. Rhubarb, as well as podophyllin and resin of jalap, is said to require the presence of bile in the intestine as a necessary condition for its operation, so that in its absence these drugs may be either altogether inactive or much less energetic than usual. It is often stated that rhubarb affects chiefly the muscular coat of the intestine, and thus purges by increasing peristalsis, but no satisfactory proof of this has apparently been educed. The purgative action is succeeded by constipation, due, no doubt, to the astringent effect of the rheotannic acid. This is presumably absorbed quickly and subsequently excreted back into the bowel, for were it not thus soon absorbed it would be swept away in the evacuations and would have no opportunity of producing its astringent action.

Kidneys.—Rhubarb has the effect of slightly increasing the amount of urine. The excretion of chrysophanic acid gives a yellowish color to this fluid, and also to the milk of nursing women. Rhubarb-urine may be distinguished from that of jaundice by its becoming purplish-red on the addition of an alkali.

Skin.—The skin may also assume a yellowish tinge from the presence of chrysophanic acid, and in rare instances cutaneous eruptions of different kinds are produced.

THERAPEUTICS OF RHUBARB.

Rhubarb is an excellent purgative for the indigestion of children, whether attended by diarrhœa or not, as it efficiently clears the intestinal canal of undigested food and irritating secretions, and its stomachic and after-astringent effects often serve a very useful purpose. A very satisfactory stomachic for young children consists of equal parts of powdered rhubarb and sodium bicarbonate (which conceals the taste of the rhubarb), with the addition of some powdered gentian; or, if preferred, the same remedies may be associated in a liquid mixture. The aromatic syrup combined with an alkali is especially serviceable in the summer complaints of children when the stools are greenish and mucous. Rhubarb is much used in diarrhœa, with intestinal weakness or relaxation, to unload the bowels of acrid secretions. In small doses, the tincture is a good stomachic tonic in dyspepsia with deficient biliary and intestinal secretions. On account of the griping which it is apt to occasion, rhubarb should rarely be prescribed alone, though in habitual constipation some individuals find benefit from chewing the root. Notwithstanding its astringent property, rhubarb is largely used as an habitual laxative, as it not only does not impair, but improves the appetite and digestion. It is adapted to those of relaxed habit, and should not be given in a sthentic state of the system, with hyperæmia of the mucous membrane, or when depletion is necessary. For the treatment of constipation, however, it has the disadvantage of requiring to be frequently repeated, its astringent after-effect being in many cases a decided objection. The compound rhubarb pill is a mild and efficient preparation for moving the bowels. It is often combined with calomel to act upon the so-called torpid liver, as in Quain's pill, which is calomel, .06 gm. (1 gr.) with compound rhubarb pill; .20 gm. (3 gr.).

CASCARA SAGRADA.

RHAMNUS PURSHIANA.—Cascara Sagrada. (Sacred Bark.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Extractum Rhamni Purshianæ.**—Extract of Cascara Sagrada. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

2. **Fluidextractum Rhamni Purshianæ.** — Fluidextract of Cascara Sagrada. **Dose, 1 c.c. (15 ♏).**

3. **Fluidextractum Rhamni Purshianæ Aromaticum.**—Aromatic Fluidextract of Cascara Sagrada. **Dose, 1 c.c. (15 ♏).**

Action of Cascara Sagrada.

The fresh bark is emetic, but after it has been kept for about two years this action is lost. Cascara sagrada is a **simple**, but efficient, **purgative**, which does not occasion much griping. Its action resembles that of buckthorn, but it is more powerful and certain in its operation. One of the advantages of this drug is that it overcomes constipation without purging, and consequently without weakening, and the stomachic properties which it derives from its bitter principle add to its value by improving the appetite and digestion.

Therapeutics of Cascara Sagrada.

Although introduced only a few years ago, cascara sagrada has established itself as a favorite and reliable remedy in habitual constipation. It should not be employed as a purgative when a powerful impression is required. It does not operate hurriedly or urgently, like many purgatives which produce watery stools, and is best suited to cases of simple constipation, or of torpor of the colon without associated disease. It may be given for the relief of catarrhal jaundice, as well as of hæmorrhoids and affections of the pelvic organs, and is often very useful in cases of dyspepsia accompanied by constipation. A special virtue of cascara sagrada is that in its continued use gradually increasing doses are unnecessary. As the condition improves the daily quantity may be reduced, and a considerable number of cases of chronic constipation are eventually cured by the drug. As the fluidextract is very bitter, it is advisable that its taste should be covered by aromatics, licorice or sal volatile, or it may be administered in chloroform water. The aromatic fluidextract is very satisfactory. A preparation known as Tinctura Laxativa (not official), consisting of equal parts of fluidextract of cascara sagrada, aromatic spirit of ammonia, spirit of chloroform, tincture of belladonna leaves, and tincture of nux vomica, is miscible in water and constitutes a pleasant simple purge which is highly recommended in habitual constipation. The dose is 1.20 to 4 c.c. (20 to 60 ♏). The preparations of cascara sagrada have to some extent supplanted the compound licorice powder, which was formerly in very general use.

SENNA.

SENNA.—Senna. **Dose, 4 gm. (60 gr.).**

Preparations.

1. **Confectio Sennæ.**—Confection of Senna. **Dose, 4 gm. (60 gr.).**
2. **Fluidextractum Sennæ.**—Fluidextract of Senna. **Dose, 2 c.c. (30 ♏).**
3. **Infusum Sennæ Compositum.**—Compound Infusion of Senna. (Black Draught.) **Dose, 120 c.c. (4 fl. oz.).**
4. **Pulvis Glycyrrhizæ Compositus.**—Compound Powder of Glycyrrhiza. (Compound Licorice Powder.) **Dose, 4 gm. (60 gr.).**
5. **Syrupus Sennæ.**—Syrup of Senna. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF SENNA.

External.—None.

Internal.—Senna is one of the class of drugs, including rhubarb, aloes, frangula and cascara sagrada, which are known as the anthracene purgatives, because they owe their activity to the presence of certain irritant anthracene ($C_{14}H_{10}$) compounds. Only a few of the latter have as yet been isolated. Senna differs from rhubarb in the absence of any astringent property, and its use is not followed by constipation. It is somewhat more liable to induce griping and nausea than rhubarb, but its tendency to gripe may be almost abolished, without greatly reducing its activity, by first exhausting it with strong alcohol. Generally five or six hours elapse between its administration and the first action of the bowels, and the stools resulting from it are watery and of a pale yellow color. Senna has little or no action on the secretion of bile. The cathartic acid in it is supposed to stimulate the muscular coat of the intestine, especially the colon, occasioning some hyperæmia, and, in consequence, the contents of the small intestine are hurried through the lower bowel, so that some undigested food may appear in the motions. Some observers state that senna acts directly as a stimulant upon the mucous membranes, and so produces a local peristalsis as it is moved along. It will cause purgation, however, if it is injected into the circulation, and this is probably because cathartic acid is excreted into the bowel. While this acid is by far the most important purgative principle of senna, there is reason to suppose that there are other substances in it which also have such action. Some constituents of the drug are absorbed and the chrysophan (chrysarobin) may cause discoloration of the urine, staining it carmine if that fluid is alkaline, or yellow if it is acid. The purgative properties of the drug may be imparted to the milk of nursing women, and therefore senna should be used with caution in this class of patients.

THERAPEUTICS OF SENNA.

Senna is a safe and reliable purgative for cases of simple constipation, but is usually combined with other remedies. As it acts largely upon the colon, it is serviceable in slight cases of fæcal accumulation. It is useful to complement the action of duodenal purgatives, and an illustration of this is seen in the old prescription of a blue pill at night and a black draught in the morning. As the compound infusion of senna is a very disagreeable mixture, however, the compound licorice powder is preferable to it. The latter preparation is still used to a considerable extent in habitual constipation, especially among children, and in the constipation of pregnancy. In pregnant women and other patients when cascara sagrada alone will not move the bowels, senna is sometimes combined with it with good effect. Confection of senna is also a very satisfactory preparation for children, and especially in the form of Tamar Indien (not official), in which it is coated with sugar or chocolate and which is readily taken by them. In the case of children manna is often combined with senna. Coffee has been recommended for masking the disagreeable taste of senna. 8 gm. (2 dr.) of [illegible] and 4 gm.

(1 dr.) of coffee may be infused in 90 c.c. (3 fl. oz.) each of hot milk and boiling water, and the whole drunk after twelve hours.

FRANGULA.

FRANGULA.—Frangula. (Buckthorn.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Frangulæ.—Fluidextract of Frangula. **Dose, 1 c.c. (15 ♏).**

ACTION OF FRANGULA.

The fresh bark is a violent gastro-intestinal irritant, but that which has been kept a year is a mild purgative, acting like senna.

THERAPEUTICS OF FRANGULA.

It is suitable for children, and for use in chronic constipation.

OXGALL.

Fel Bovis.—Oxgall.

Preparation.

Fel Bovis Purificatum.—Purified Oxgall. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ACTION OF OXGALL.

Oxgall when added to albuminous solutions delays their decomposition. It aids in the absorption of fats. If given by the mouth it is mostly absorbed from the intestine and acts as a **cholagogue.**

THERAPEUTICS OF OXGALL.

Oxgall has been used as a cholagogue purgative, not infrequently associated with aloes. Although theoretically of value in replacing deficient biliary secretion, it has the great disadvantage of disturbing the gastric digestion, and on this account is not now very much employed. It may be found useful, however, when given as an enema in cases of impacted fæces in which there is not sufficient room in the rectum for a bulky injection. For this purpose 30 to 60 gm. (1 to 2 fl. oz.) of oxgall in 500 c.c. (1 pint) of water should be used. It is claimed that bile has some antitoxic power with reference to the poisons produced by pathogenic micro-organisms, and oxgall has sometimes been used as an antiseptic in typhoid fever and in intestinal fermentation.

(*c*) **Drastic purgatives.**

EUONYMUS.

EUONYMUS.—Euonymus. (Wahoo. Spindle Tree.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

Extractum Euonymi.—Extract of Euonymus. (Euonymin.) **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Fluidextractum Euonymi. — Fluidextract of Euonymus. **Dose, 0.5 c.c. (8 ♏).**

ACTION OF EUONYMUS.

In small doses euonymus is a gastric stimulant, promoting appetite and digestion. In both moderate and large doses it is also regarded as an hepatic stimulant, **increasing the biliary secretion,** while in the latter amounts it is distinctly irritant to the intestine and is an energetic purgative. It owes its activity to its euonymin, a substance which has somewhat the same action on the heart as digitalis. The drug is also said to have slight diuretic and expectorant effects. Beyond its tonic and purgative properties it probably has no special virtue.

THERAPEUTICS OF EUONYMUS.

It has been chiefly employed in cases of constipation associated with impaired functional derangement of the liver, and is often combined with calomel. In dyspepsia its administration two or three times a week is sometimes attended with good results.

PODOPHYLLUM.

PODOPHYLLUM.—Podophyllum. (May Apple. Mandrake.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Fluidextractum Podophylli.**—Fluidextract **Dose, 0.5 c.c. (8 ♏).**

2. **Pilulæ Podophylli, Belladonnæ et Capsici.**—Pills of Podophyllum, Belladonna and Capsicum. **Dose, 1 pill.**

3. **Pilulæ Catharticæ Vegetabiles.**—Vegetable Cathartic Pills. **Dose, 2 pills.**

4. **Resina Podophylli.**—Resin of Podophyllum. (Podophyllin.) **Dose,** (purgative) **0.015 gm. = 15 milligm. ($\frac{1}{4}$ gr.);** (laxative) **0.005 gm. = 5 milligm. ($\frac{1}{10}$ gr.).**

Action of Podophyllum.

External.—Podophyllum is irritant to the skin and mucous membranes, and from denuded surfaces it may be absorbed and produce a purgative effect.

Internal. *Gastro-intestinal Tract.*—Podophyllin is a drastic purgative. Large doses cause marked gastro-intestinal irritation, and have been known to prove fatal from acute inflammation of the bowel. Medicinal doses occasion considerable colic and in some instances nausea. Podophyllin is like aloes in the **slowness** of its action, catharsis rarely occurring earlier than ten or twelve hours after its administration, and sometimes not for twenty to twenty-four hours. The watery passages which it produces are stained dark by the presence of bile. In small doses it probably increases the secretion of that fluid—at all events, under its action there is an augmentation of the solids in it. When it is given in purgative doses the quantity of bile is said not to be increased, though more of it is emptied from the gall bladder into the intestine. Podophyllin would thus seem to act both as a **direct and indirect cholagogue.** An old name for this drug is Vegetable Mercury. Both podophyllin and podophyllotoxin cause purgation when injected subcutaneously, and this is probably because after absorption they are excreted into the bowel, since they have been detected in the fæces when administered in this way. Podophyllotoxin occasions the formation of methæmoglobin in the red corpuscles when added to blood outside the body, and when thrown into the circulation in large amount gives rise to glomerular nephritis and hæmorrhages into various organs. While it has a depressant effect upon the central nervous system, this is thought to be indirect, and due to the shock and hæmorrhage resulting from its severe intestinal action.

THERAPEUTICS OF PODOPHYLLUM.

As podophyllum is believed to act especially on the liver, it is quite largely employed in constipation with hepatic derangement, and particularly in so-called bilious attacks. In congestion of the portal circulation, in catarrhal and malarial jaundice, and in ascites it generally acts with great efficiency, and hæmorrhoids of recent formation which bleed in consequence of stasis in the portal circulation may sometimes be cured by a brisk podophyllum cathartic. Habitual constipation due to inactivity of the muscular coat of the intestine may also be cured by the nightly use of a small dose of podophyllin combined with belladonna. It should not be given in association with promptly acting purgatives, as in that case it will be carried through the bowel before it has had time to produce its effects. It may often be advantageously combined with nux vomica, or with hyoscyamus to prevent griping. The only preparation that should be employed is the resin (podophyllin), and this is almost universally administered in pill form.

LEPTANDRA.

LEPTANDRA.—Leptandra. (Culver's Root.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Extractum Leptandræ.**—Extract of Leptandra. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Fluidextractum Leptandræ.**—Fluidextract of Leptandra. **Dose, 1 c.c. (15 ♏).**
3. **Pilulæ Catharticæ Vegetabiles.**—Vegetable Cathartic Pills. **Dose, 2 pills.**

ACTION OF LEPTANDRA.

Recent leptandra root acts as a violent cathartic, and sometimes as an emetic. It is an excellent cholagogue, owing its activity to leptandrin, and appears to have a special influence upon the muciparous follicles of the intestine.

THERAPEUTICS OF LEPTANDRA.

It acts very advantageously in cases of duodenal indigestion and chronic constipation.

SCAMMONY.

SCAMMONIUM.—Scammony. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Resina Scammonii.—Resin of Scammony. **Dose, 0.200 gm = 200 milligm. (3 gr.).**

ACTION OF SCAMMONY.

Scammony is a **hydragogue cathartic** of rapid and energetic action. It has no effect until it enters the duodenum, and the presence of the bile appears to be essential for its activity. With the aid of the bile it powerfully **stimulates** the **intestinal glands** to increased secretion, and incidentally causes more or less hyperæmia of the bowel and stimulation of its muscular coat. In about four hours after its administration a profuse watery evacuation occurs, and its action is attended with considerable griping. In over-doses it is likely to cause violent gastro-enteritis. No purgative effect is produced when it is injected subcutaneously or intravenously.

THERAPEUTICS OF SCAMMONY.

As it is a prompt and efficient cathartic, scammony may be used in cases of obstinate constipation and impaction of fæces. On account of its violent properties, however, it is usually best to combine with it some carminative or less active purgative. It is often serviceable in the treatment of dropsical effusions and of cerebral affections, and is well adapted for severe cases of mania and hypochondriasis. For dropsy the compound jalap powder is more commonly employed, but when this fails to act recourse may be had to scammony. Scammony is efficient in clearing mucus from the intestines, and is anthelmintic against both round-worms and tape-worms. For children, however, this remedy is unnecessarily severe in the treatment of worms. Where active purgation is required in children, calomel and scammony may be given triturated with sugar of milk, or scammony may be administered rubbed up with milk or with syrup of rhubarb.

JALAP.

JALAPA.—Jalap. **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Pulvis Jalapæ Compositus.**—Compound powder of Jalap. **Dose, 2 gm. (30 gr.).**
2. **Pilulæ Catharticæ Compositæ.**—Compound Cathartic Pills. **Dose, 2 pills.**
3. **Pilulæ Catharticæ Vegetabiles.**—Vegetable Cathartic Pills. **Dose, 2 pills.**
4. **Resina Jalapæ.**—Resin of Jalap. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF JALAP.

External.—It causes pain and irritation when applied to the nostrils in fine powder.

Internal.—The action of jalap is very much the same as that of scammony, but it is somewhat less powerful and produces rather less colic, while it promotes even greater **intestinal secretion.** It has also been credited by some observers with diuretic properties. Jalapin administered by the mouth cannot be detected in the fæces or urine, and is therefore supposed to undergo complete or partial oxidation in the body.

THERAPEUTICS OF JALAP.

Jalap is occasionally employed for severe constipation, and an old prescription consists of equal parts of powdered jalap and calomel, well triturated. The dose is from .30 to .60 gm. (5 to 10 gr.). This is known as Rush's thunderbolt. Curiously enough, it does not gripe. The principal use of jalap is in the treatment of all forms of dropsy, and particularly that from Bright's disease. For this purpose the compound powder, which produces abundant watery evacuations, is commonly employed, and while the diuresis which also is frequently observed after its administration may possibly be due in a small measure to the effect upon the kidney of the jalap itself, the action of the potassium bitartrate and the relief of the engorgement of renal vessels resulting from the drain of fluid from the intestinal vessels would seem to be [illegible] tors in the augmentation of the urine. In order to enhance the diuretic effect, some clinicians are in the habit of prescribing an additional amount of the salt with each dose of compound jalap powder. For renal dropsy, and to avert the dangers of uræmia, it is customary to aid and supplement the action of the powder by the more or less frequent use of vapor baths. Jalap should not be employed for too long a time continuously, since it may occasion a form of gastro-enteritis and, in addition, may favor cardiac weakness. It is sometimes given in the beginning of inflammations and fevers or other acute diseases where an efficient cathartic is required, and is also found of service in various forms of cerebral congestion. The drug is naturally contra-indicated in all inflammatory states of the alimentary canal, and large doses of it should not be given if the intestinal mucous membrane is liable to inflame easily.

GAMBOGE.

CAMBOGIA.—Gamboge. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

Preparation.

Pilulæ Catharticæ Compositæ.—Compound Cathartic Pills. **Dose, 2 pills.**

ACTION OF GAMBOGE.

Gamboge belongs to the class of drastic or hydragogue cathartics, and is violent in its action, causing marked irritation of the alimentary canal, energetic peristalsis, with considerable griping, and greatly augmented intestinal secretion. It owes its activity to gambogic acid, which, however, is insoluble, and seldom acts unless it is accompanied with the inert bodies of the crude drug. Most of it escapes unaltered in the stools, but some is absorbed, and small and repeated doses are slightly diuretic. It colors the urine yellow.

THERAPEUTICS OF GAMBOGE.

As its action is somewhat uncertain, and is so violent and apt to cause severe colic when it does take place, gamboge is not often prescribed, except as the official pill into which it enters (Pilulæ Catharticæ Compositæ). Even the gum-resin, on account of its solubility, is irritant to the stomach, so that the drug should always be used in pill form. It should also always be administered in combination with other remedies. It is quite an efficient anthelmintic, and is occasionally given with other agents of this class.

COLOCYNTH.

COLOCYNTHIS.—Colocynth. (Bitter Apple. Bitter Gourd. Bitter Cucumber.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Extractum Colocynthidis.**—Extract of Colocynth. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**
2. **Extractum Colocynthidis Compositum.**—Compound Extract of Colocynth. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**
3. **Pilulæ Catharticæ Compositæ.** — Compound Cathartic Pills. **Dose, 2 pills.**
4. **Pilulæ Catharticæ Vegetabiles.** — Vegetable Cathartic Pills. **Dose, 2 pills.**

ACTION OF COLOCYNTH.

External.—Colocynthin is irritant to mucous membranes, especially those of the eye, nose and throat.

Internal.—The action of colocynth varies in accordance with the amount given and the mode of administration. In small doses it acts as a simple **bitter,** increasing appetite and gastric secretion. In larger doses it is a **powerful intestinal stimulant,** augmenting the biliary and intestinal secretions, and accelerating the movements of both the large and small intestine. It occasions considerable griping pain, but the amount of colic does not seem to be entirely dependent upon the quantity taken, as even small doses may be followed by much discomfort if the drug is given alone. It produces abundant watery passages, and if the dose is excessive may set up enteritis, with bloody stools. Toxic symptoms are not infrequently met with from the use of colocynth, as it is one of the drugs commonly employed for the purpose of producing abortion. It appears to have a distinct diuretic action, for c[illegible] is stated to excite renal irritation or inflammation w[illegible] either hypodermatically or by the mouth, an[illegible] powder is inhaled during its manufacture. This glucoside not only purges when swallowed, but also when administered subcutaneously or by intravenous injection, a result probably due to its excretion into the intestine, though it has been suggested that this and some of the other purgative principles may have a specific action quite apart from their irritant effects. Applied to the skin of the abdomen, colocynth causes intestinal pain and some purgation.

THERAPEUTICS OF COLOCYNTH.

Colocynth is perhaps the most generally useful of the drastic cathartics, but it is of great importance that it should be administered in carefully regulated doses and properly combined with other remedies. On account of the griping to which it gives rise it should never be given by itself, but a proper mode of employment renders its effects almost comparable to those in simple purgatives. The violence of its action may be moderated to a considerable degree by its administration with aromatic substances or with intestinal sedatives such as belladonna or hyoscyamus. The compound extract is a safe, effective, and not unpleasant preparation for the relief of constipation, and the compound cathartic pill is also a very serviceable combination. Some prefer the official vegetable cathartic pill. For some cases of habitual constipation the compound extract, combined with the extract of belladonna and physostigma, seems to answer very well. In cerebral congestion the preparations of colocynth are employed for their revulsive effect. Hypochondriasis and melancholia, when associated with sluggishness of the large intestine and fæcal accumulations, are benefited by colocynth, as by other hydragogue cathartics. Notwithstanding its diuretic action, even in the condition of health, colocynth is not so generally serviceable in the treatment of dropsy as jalap, although it is more or less used. Like other remedies of its class, it is contra-indicated in inflammatory states of the intestinal canal. It is often stated that colocynth is unsafe during pregnancy, but there seems to be no good reason for this assertion, provided the remedy be administered with due caution. Some of the most eminent obstetricians are in the habit of prescribing it when required, often with hyoscyamus and nux vomica. Colocynth in combination with colchicum is found in some popular remedies for gout.

ELATERIN.

ELATERINUM.—Elaterin. **Dose, 0.005 gm. = 5 milligm. ($\frac{1}{12}$ gr.).**

Preparation.

Trituratio Elaterini.—Trituration of Elaterin. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

ACTION OF ELATERIN.

External.—Elaterium is a marked local irritant. It is stated to cause ulcerations upon the fingers of those who handle the fruit and prepare the drug for the market.

Internal.—The action of elaterin closely resembles that of colocynth, but is much more energetic, and it is regarded as the **most powerful hydragogue cathartic known.** The drain of fluid which it induces even in medicinal doses is so profuse that its use is commonly attended with considerable exhaustion and prostration. When externally applied, it is said, as well as when it is injected into the circulation, it also produces a purgative effect. If given in properly regulated amount, it occasions comparatively little pain or irritation, notwithstanding the very free catharsis caused. In small doses by the mouth it increases the secretion of saliva and promotes appetite.

THERAPEUTICS OF ELATERIN.

On account of the violence of its action, elaterin is not adapted to cases of ordinary constipation. It is the most efficient of the hydragogue cathartics in general dropsy or in ascites, and while there appears to be no authority for the claim that it is capable of increasing the intestinal elimination of urea, its practical value in uræmia has been demonstrated by clinical experience. The great drawback to its use is the depression resulting from it, and hence great care should be exercised not to administer it in too large doses, and also support the strength of the patient by appropriate when it is employed. Almost always it may be advantageously followed by alcoholic stimulants. It ought never to be given in cases of marked exhaustion, and its injudicious use in the later stages of dropsical affections may induce fatal collapse. It should always be given with the greatest caution, if at all, in disease of the heart, but under proper restrictions it may be employed for the effusion in pericarditis, as well as in pleurisy. In cerebral congestions or effusions and in other affections of the brain it is valuable as a derivative. Elaterin has been employed in various diseases for the purpose of depletion, but to accomplish this the salines are usually preferable. Especially is this the case if there is present any gastro-intestinal irritation or inflammation, in all instances of which, it need scarcely be said, elaterin is contra-indicated. Clutterbuck's elaterium, the dose of which is .008 gm. (1/8 gr.) has been used, because of the confidence reposed in its reliability, to a considerable extent in uræmia and puerperal eclampsia.

CROTON OIL.

OLEUM TIGLII.—Croton Oil. **Dose, 0.05 c.c. (1 ♏).**

Action of Croton Oil.

External.—Croton oil is an **irritant** of extraordinary power. A single drop applied to the skin causes pain, hyperæmia and prompt vesication. The vesicles thus formed rapidly undergo **pustulation**, while the surrounding tissue becomes inflamed and œdematous. The pustules may be umbilicated, but differ from variolous pustules in that they vary greatly in their size. It has now been determined that the subcutaneous injection of croton oil, provided that it contains free acid, is capable of causing the formation of pus without the presence of microbes, which was formerly thought by many to be necessary for such action.

Internal.—On the mucous membrane of the mouth, fauces, œsophagus and stomach croton oil exerts its irritant action, as upon the skin, but it is found that if the free acid in it is removed, this irritant effect will be prevented, while the oil will simply cause purgation in consequence of its saponification by the intestinal juices. Under these circumstances it is quite bland, and can only be distinguished from castor oil by its more energetic purgative action. Ordinarily croton oil is such a powerful irritant poison that except in the smallest doses it produces marked gastro-enteritis, with nausea and vomiting, severe abdominal pain, violent purging, with bloody stools, collapse and death. A drop of it will cause considerable colic and in the course of one or two hours an evacuation of the bowels. This is likely to be followed by others, the passages becoming more and more fluid. At the same time there are produced hyperæmia of the gastro-intestinal tract, increase of secretion, and probably increased peristalsis. Whether the latter is due simply to the irritation or to some action of the drug exerted after absorption is undetermined, but the other effects are attributable to the local action of the oil. As to what becomes of croton oil in the body nothing is positively known, but it is thought probable that part of it is excreted into the large intestine. Applied to the skin, the oil may cause free purgation. The toxalbumin, *Crotin,* which is found in the Croton Tiglium, but which does not pass into the oil, resembles that of the castor oil bean (*Ricin*), but is considerably less poisonous.

THERAPEUTICS OF CROTON OIL.

External.—Croton oil was formerly employed to produce counter-irritation, especially in diseases of the chest and of the joints, but is not often used for this purpose now, at least in an undiluted state, as in many instances permanent cicatrices are left as the result of the suppuration caused. Corson's paint is a 5 to 10 per cent. solution of croton oil in ether, to which a small quantity of tincture of iodine is added to color it. In very obstinate cases of ringworm, which have resisted other remedies, croton oil is sometimes applied to a spot about the size of a dime. It should never be used for such purposes in delicate children.

Internal.—The chief advantages of croton oil are its rapid action as a drastic cathartic and the smallness of the dose required. It is therefore of great value for
unconscious or maniacal, and it is used

tent in cerebral apoplexy, uræmia and puerperal eclampsia. As a revulsive in cerebral congestion it may be of service by increasing vascular dilatation in the bowel, and thus lowering the intra-cranial blood-pressure. It is unsuitable for the treatment of dropsy or of other conditions requiring frequency of administration, as the action may be followed by considerable irritation. In obstinate constipation when there is no organic intestinal obstruction a dose of croton oil often acts very happily. Thus, it is appropriate in cases of fæcal impaction, without inflammatory symptoms, and the constipation due to lead poisoning may not infrequently be overcome by it after less energetic cathartics have failed. It is contra-indicated in all very feeble persons, in pregnant women, and in patients suffering from hæmorrhoids, peritonitis, or affections of the stomach or bowels. As a rule, it should be avoided in children, but occasionally it may be called for in them. As washing with alcohol removes the acidity without impairing the purgative effect of the oil, a preparation so treated is the best for this class of subjects, and it may be administered rubbed up with sugar of milk. The unpleasant effects of croton oil may be modified by combining it with other remedies, as the compound extract of colocynth and extract of belladonna, and if in any exceptional case there should seem to be sufficient reasons for giving it continuously for a short period, it would certainly be advisable to employ it in this way. The treatment of poisoning by croton oil is the same as that for gastro-enteritis from other causes. Fortunately, when an over-dose is swallowed, vomiting is usually very promptly excited, and hence very large quantities have been taken without producing a fatal result. In case free emesis has not been caused by the drug the first step in the treatment would of course be to evacuate the stomach.

COLCHICUM.

COLCHICI CORMUS.—Colchicum Corm. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparation.

Extractum Colchici Cormi.—Extract of Colchicum Corm. **Dose, 0.065 gm. = 65 milligm. (1 gr.)**

COLCHICI SEMEN.—Colchicum Seed. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

Preparations.

1. **Fluidextractum Colchici Seminis.**—Fluidextract of Colchicum Seed. **Dose, 0.2 c.c. (3 ♏).**
2. **Tinctura Colchici Seminis.**—Tincture of Colchicum Seed. **Dose, 2 c.c. (30 ♏).**
3. **Vinum Colchici Seminis.**—Wine of Colchicum Seed. **Dose, 2 c.c. (30 ♏).**

COLCHICINA.—Colchicine. **Dose, 0.0005 gm. = 0.5 milligm. ($\frac{1}{128}$ gr.).**

Unofficial Preparation.

Colchicinæ Salicylas.—Colchicine Salicylate. **Dose, 0.0006 gm. ($\frac{1}{100}$ gr.).**

ACTION OF COLCHICUM.

External.—Colchicum is a decided local irritant, causing redness and smarting when applied to the skin, while the dust, when inhaled, excites sneezing and conjunctival hyperæmia, with a burning sensation in the mouth and throat.

Internal. *Gastro-intestinal Tract.*—In the great majority of instances moderate doses of colchicum give rise to no appreciable effect. In some individuals, however, there is produced after a time a feeling of malaise, with discomfort in the stomach and bowels, followed by some nausea and diarrhœa. It may also have the effect of slightly increasing the biliary secretion. In large amounts it causes salivation and nausea, with **violent vomiting and purging**, and afterwards a condition of depression, apathy and collapse; and the same effects are produced by the intravenous injection of colchicine. Several hours elapse after the administration of the drug before these symptoms are elicited, and the reason for this is stated to be that it is not the colchicine itself which produces them, but an oxidation product which is formed from it in the organism. In man, at least, it would appear that the gastro-intestinal irritation is not altogether an inflammatory action, since the intestine may appear quite normal after death, and there is seldom more than a simple catar
the duodenum. When ecchymoses, etc., have been

have been ascribed to the mechanical effects of the extremely energetic peristalsis occasioned. The explanation of the symptoms which has been offered is that there appears to be an increased irritability of the intestinal tract, so that normal impulses, which ordinarily keep up a moderate peristalsis, now produce a very violent one. In mammalian animals poisoned with colchicine, however, it is stated that the alimentary canal presents all the appearances of acute gastro-enteritis; so that this explanation would seem somewhat inadequate. The amount of the drug ingested appears to have little influence on the duration of the preliminary stage of quiescence.

Circulation and Respiration.—In animals the heart's action and blood-pressure remain unaffected, and while in man the pulse may become small, rapid and thready, this is no doubt simply the result of the collapse. The respiration is found to be slow, though deep and full at first. Later it becomes shallow, and death is due to failure of the respiratory centre, the heart continuing to beat for some time afterward.

Nervous System and Muscles.—The action on the central nervous system is almost purely depressant, but it is believed that the nervous symptoms caused are probably secondary to the effect upon the abdominal organs, rather than due to any direct central action. In the case of mammals poisoned with colchicine, when the collapse sets in, the movements are found to become slow and difficult, more especially in the posterior extremities, which are eventually rendered completely motionless. The paralysis then extends upwards until the movements of the fore limbs and respiratory muscles are involved, when death occurs from asphyxia. In man the consciousness and intelligence as a rule remain unimpaired, though there is generally some giddiness. In exceptional instances there is more or less confusion, and even delirium may precede the collapse. In the frog colchicine is said to have little or no effect, but if the solution be exposed for some time to the air, so that oxydicolchicine is formed, it is found to cause a prolongation of the muscular contraction similar to that seen after veratrine, and eventually a tetanus resembling that due to strychnine. This oxidation product does not seem to be capable of formation within the frog's system, as in that of a warm-blooded animal.

Kidneys.—In some instances the urine is slightly increased, while in others complete anuria, lasting for many hours, is produced. According to the latest and most reliable researches, it has been found that small quantities of colchicine increase the amount, and both the urea and uric acid, as well as the fluid, while under larger doses the fluid is diminished, the urea and uric acid being less affected than with the smaller ones. In animals, it is stated, bloody urine sometimes results from the colchicine.

THERAPEUTICS OF COLCHICUM.

Colchicum has long been used empirically in the treatment of gout, but it is not now as universally employed in this disease as formerly. Authorities differ as to its value, and some physicians have denied that it has any beneficial effect. It has been shown, as has been mentioned, that it increases the elimination of uric acid, but unfortunately for the explanation of its remedial action on rational grounds, it seems now to be established that gout is not due to a deficient excretion of this agent. As the pathology of the disease, therefore, remains entirely uncertain, it can only, like other medicines, be used in its treatment in a purely empirical manner; but it appears to be a fact that in a considerable proportion of cases, at least, its administration is attended with more or less decided benefit. In these, if given in suitable quantities during the attack, it markedly relieves the pain, while in smaller doses between the attacks it seems to lessen their severity. In certain instances also where headache, neuralgia, dyspepsia, neuritis, eczema, conjunctivitis, bronchitis and various other ailments recur in gouty subjects, it is found useful. According to some who consider the drug almost a specific in acute gout, provided that it be pushed until it causes a slight griping or laxity of the bowels, it is the opinion that it not only does not have any marked effect in preventing attacks, but that it often seems to hasten their onset. The active principle, colchicine, is believed by some to be more successful in gout than any form of the crude drug. Colchicum is [illegible] to some extent in the treatment of chronic rheumatism and so-called rheumatic gout, or rheumatoid arthritis, and here, as well as in subacute or chronic gout, it is advised that it should be given in conjunction with potassium iodide. In gout the commencement of the treatment with a purgative is usually advisable, and it is also a common practice to administer colchicum with magnesium sulphate or carbonate. A well-known formula is: Extract of colchicum corm, calomel, powdered aloes, powdered ipecacuanha, of each .06 gm. (1 gr.), with .015 to .03 gm. (¼ to ½ gr.) of extract of nux vomica. The seed is said to be less active than the corm. To elderly persons and to those whose circulatory apparatus is feeble it is advised that colchicum should be administered with caution, or not at all. Moreover, some individuals exhibit an intolerance of even very small doses, which quickly produce intestinal irritation or cardiac depression. It is found that the paroxysms of gout may often be suppressed by large purgative doses, but experience has shown that this use of the drug is dangerous, as such suppression is liable to be followed by serious internal disease.

TOXICOLOGY.

In the treatment of colchicum poisoning an emetic and a cathartic should be administered at once, if the stomach and bowels have not been freely evacuated. Large quantities of warm water may also be given to aid in these operations and to act on the kidneys. Tannic acid is a chemical antidote, forming an insoluble tannate with the alkaloid, and though experiments upon animals have shown that it is not to be relied upon, it should be thoroughly tried in large amount. Otherwise the treatment must be symptomatic. Opium is usually required to relieve the pain and check vomiting and diarrhœa, as well as stimulants to counteract depression.

PHYTOLACCA.

PHYTOLACCA.—Phytolacca. (Poke Root.) **Dose,** (emetic) **1 gm. (15 gr.)**; (alterative) **0.125 gm. = 125 milligm. (2 gr.).**

Preparation.

Fluidextractum Phytolaccæ.—Fluidextract of Phytolacca. **Dose,** (emetic) **1 c.c. (15 ♏)**; (alterative) **0.1 c.c. (1½ ♏).**

ACTION OF PHYTOLACCA.

Phytolacca is an emetocathartic, acting slowly and causing considerable depression. In large doses it possesses also some narcotic properties.

THERAPEUTICS OF PHYTOLACCA.

Phytolacca is used as a laxative and alterative. Recently a preparation made from the berries (not official) has been used to reduce adipose tissue.

(*d*) Intestinal Antiseptics.

Reference should also be made to bismuth (p. 586).

BETANAPHTHOL.

BETANAPHTHOL.—Betanaphthol. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF BETANAPHTHOL.

This substance is antiseptic and irritant. In animals, in large doses, it causes symptoms similar to those of phenol poisoning, except that the convulsions are less pronounced, and in the dog are not observed at all. In solution or in vapor it is irritant to mucous membranes, and in the course of excretion it induces pain in the bladder and urethra, with strangury, and hyperæmia and swelling of the mucous membrane. Either when injected subcutaneously or absorbed from the alimentary canal in sufficient quantity it excites acute nephritis, with albuminuria and hæmoglobinuria. In man, some nephritis is said to have been caused from its external application.

THERAPEUTICS OF BETANAPHTHOL.

Betanaphthol was first introduced as an antiseptic in dermatological practice and used, in a 10 per cent. ointment, in scabies, ringworm and psoriasis; it is, however, irritating in eczema. It is a remedy of great value in obtaining intestinal antisepsis, bacteriological investigations showing that it destroys certain micro-organisms *in situ* when administered to the extent of 2.70 gm. (40 gr.) a day. As it is more or less tating to the stomach it should be administered in keratin-coated pills when its action is desired in the intestine only. It is useful in flatulent dyspepsia, chronic gastric or intestinal catarrh, and dilatation of the stomach. Good results have also been reported from its employment in typhoid fever, tuberculous ulceration of the bowels, scarlatina, diphtheria and erysipelas. Fatal inflammation of the kidneys has resulted in some instances where it has been used in large quantities.

NAPHTHALENE.

NAPHTHALENUM.—Naphthalene. (Naphthalin.) **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF NAPHTHALENE.

Naphthalene is antiseptic, antifermentative, disinfectant and deodorant. Since it is not absorbed by the organism, it acts only upon the mucous membrane of the bowels.

THERAPEUTICS OF NAPHTHALENE.

External.—Naphthalene is a useful antiseptic for ulcers, cancers and pus cavities, and can be employed in watery emulsion, in alcoholic solution, or in a dry form. In ointments, in which it is sometimes combined with calomel, it has been used with advantage for chancres, chancroids, syphilitic ulcers, sloughing wounds, psoriasis and chronic eczema.

Internal.—It is a true intestinal antiseptic, and is of great value in dysentery and in catarrhal, typhoid and tuberculous diarrhœa, where it markedly lessens or entirely abolishes the fœtor of the movements. It has also been used as a vermifuge (dose, .20 to .40 gm.; 3 to 6 gr.). Success in the treatment of dysentery usually requires a daily dose of from 4 to 8 gm. (1 to 2 dr.), best administered in starch wafers.

RESORCINOL.

Resorcinol.—Resorcinol. (Resorcin.) **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF RESORCINOL.

Resorcinol was originally introduced as an antipyretic, but is now seldom employed for this purpose, as the necessarily large doses are too depressant to the heart. It is powerfully antiseptic. Dark-colored urine, often described as smoky, is sometimes seen after large doses.

THERAPEUTICS OF RESORCINOL.

External.—A solution of resorcinol in glycerin, 1 to 4, is a good application for removing epidermic scales in chronic skin diseases and also the scales in seborrhœa sicca of the scalp; here it doubtless inhibits the action of the bacteria which may be the cause of dandruff. A lotion of resorcinol, 1; ether, 1; castor oil, 1; Cologne, 10; alcohol, 35, may be used both for dandruff and alopecia. A 5 per cent. solution of resorcinol is an excellent antiseptic injection for the bladder in cystitis.

Internal.—This remedy is of great value in fermentative dyspepsia when administered, well diluted, one hour after the ingestion of food. The daily amount should be at least 1.50 gm. (22 gr.).

SALICYLIC ACID.

ACIDUM SALICYLICUM.—Salicylic Acid. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

AMMONII SALICYLAS.—Ammonium Salicylate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

LITHII SALICYLAS.—Lithium Salicylate. **Dose, 1 gm. (15 gr.).**

SALICINUM.—Salicin. **Dose, 1 gm. (15 gr.).**

SODII SALICYLAS.—Sodium Salicylate. **Dose, 1 gm. (15 gr.).**

STRONTII SALICYLAS.—Strontium Salicylate. **Dose, 1 gm. (15 gr.).**

ACTION OF SALICIN, SALICYLIC ACID, AND THE SALICYLATES.

External.—Salicylic acid is somewhat more powerfully **antiseptic** than phenol, but its salts are less strongly antiseptic. Salicin, it is stated, has no antiseptic properties unless decomposed into its constituents. Applied to the skin, salicylic acid has the effect of softening the epidermis and also of **diminishing perspiration.** It is irritant to mucous membranes and abraded surfaces, and its continued application in concentrated form may have some destructive action on the tissues. When inhaled or applied to the fauces, it excites sneezing and coughing.

Internal. *Alimentary Tract.*—When swallowed in powder salicylic acid causes irritation, and sometimes soreness, of the mouth and throat. In the stomach it is also irritant, and is apt to cause pain, nausea and vomiting, with more or less congestion. In some instances even erosion of the mucous membrane is produced. In dilute solution, however, it has no such effect. Salicin is a bitter tonic, instead of an irritant to the stomach, though after absorption its action is similar to that of the acid. The sodium and lithium salts are also much less irritating than salicylic acid. In the body salicin, when given by the mouth, is decomposed into glucose and saligenin ($C_7H_8O_2$), and this process no doubt takes place in the intestine, for when it is injected into the circulation it is chiefly excreted unchanged. Saligenin is further decomposed into salicylic acid, salicylous acid or salicylic aldehyde ($C_7H_6O_2$), and salicyluric acid ($HC_9H_8NO_4$).

Liver.—Salicylic acid and the salicylates **increase the biliary secretion,** through some specific action, it is thought, on the liver cells, and they are probably the strongest cholagogues known. Both the amount of bile and the solids are augmented, and in one case of biliary fistula it was found that the concentration of the secretion was increased, the solids being augmented in greater proportion than the fluid. In dogs, however, the bile is stated to become more liquid, and to contain less than the usual amount of solid constituents.

Heart and Circulation.—In animals small doses intravenously injected have the effect of accelerating the heart, probably from a direct action on the cardiac muscle, while the blood-pressure is increased from stimulation of the vaso-constrictor centre in the medulla. Very large doses produce weakness and slowness of the heart, which becomes dilated, and a fall in the blood-pressure. The lowered pressure is due principally to the cardiac action of the drug, and to a less extent, it may be, to depression of the vaso-constrictor centre. It has been shown by sphygmographic tracings that in man full doses of sodium salicylate (5 gm.—77 gr.—in two doses of 2.5 gm.—

38½ gr. each, given in water with an interval of one hour between the doses) possess rather a raising than a lowering action upon the intra-arterial blood-pressure and the frequency of the pulse. In febrile cases, some of which were rheumatic, the continued use of the drug in doses of 2 to 4.5 gm. (30 to 70 gr.) *per diem* did not produce any appreciable depression. The depressing effect of salicylates upon the heart which has sometimes been observed clinically may, it is thought likely, have been due to impurities in the drug, since it has been shown that orthocreosotic acid is a powerful cardiac poison, and that artificial salicylic acid and its sodium salt, containing creosotic acids, were fatal to rabbits, while much larger doses of the pure acid had no injurious effects.

Blood.—It is now known that salicylic acid, which is readily absorbed, exists in the blood as the salicylates of the alkalies. By some observers it has been found to be taken up from the blood by the synovial membranes and rapidly excreted into the cavities of the joints. If this is the case, it would thus be capable of exercising a specific action in acute rheumatism. The number of leucocytes in the blood is increased.

Respiration.—In man, acceleration of the respiration and dyspnœa are occasionally observed, and such results have been attributed to a central action. In animals the respiration is first quickened to some extent, and then slowed; showing probably that the respiratory centre is at first stimulated and then depressed. Very large doses eventually paralyze the respiration, and death is apparently due to this cause, the heart continuing to beat for some time afterwards.

Temperature.—Medicinal doses have no influence on the normal temperature. Very large quantities, by producing a collapse-like condition, may bring about some reduction in it. In fever patients, however, a distinctly **antipyretic** action is often observed, though the fall in temperature is usually smaller and of shorter duration than that caused by drugs of the acetanilide series. This action has been attributed to dilatation of the cutaneous vessels and an increase in the output of heat. Salicylic acid and salicin are **antiperiodic.**

Skin.—It has been shown by plethysmographic measurements that the vessels of the skin are dilated by salicylic acid in the same way as by the antipyretics, and this action is supposed to be due to excitation of the vaso-dilator centres in the medulla which control the cutaneous areas. Probably the reason that such dilatation does not cause any reduction of the normal temperature is that it is counter-balanced by an increased heat formation. In some individuals skin eruptions of various character (possibly due in great measure to the dilation of the cutaneous vessels) are observed, but they occur less frequently than under the use of the antipyretics. The perspiration which so often follows the administration of salicylic acid and its salts is due, it is thought, rather to increased activity of the sweat centres than to the vascular dilation.

Nervous System.—Except in cases where a special idiosyncrasy is present, the effects of salicylic acid on the central nervous system are unimportant. In animals no marked depression appears to be produced except in the medulla oblongata. It is true that convulsions sometimes make their appearance before death, but they are believed to be due to the asphyxia caused, rather than to any direct effect of the drug. In the medulla there is apparently at first a stimulation and subsequently a depression of the respiratory, the vaso-constrictor, and, probably, the vaso-dilator centres.

Kidneys.—Salicylic acid has a moderate diuretic action, probably increasing the urinary secretion by its irritating effect on the renal epithelium. The increased formation of urea may also be a factor in the diuresis. Nephritis, with albuminuria and hæmaturia, has occasionally been observed. An increase in the nitrogen and sulphur of the urine is caused by salicylic acid, indicating a considerably augmented decomposition of the proteids of the body. There is also a very marked increase in the excretion of uric acid, different observers estimating this at from 30 to 100 per cent. Salicylic acid first appears in the urine in from ten to thirty minutes after ingestion. It is excreted by the kidneys to some extent unchanged, but for the most part in combination with glycocoll. The compound thus formed, salicyluric acid, is analogous to hippuric acid. It reduces Fehling's solution, and has been mistaken for sugar. The color of the urine is often dark or greenish in consequence of the presence of pyrocatechin or indican, or both. The urine of persons taking salicylic acid gives a **purple** tint **with ferric chloride.** Under the use of salicylic preparations the normal acidity of the urine is increased, and alkaline urine may become acid. It acts as an antiseptic to the mucous membrane of the urinary tract, and will remain undecomposed for a considerable time after it has been passed.

Salicylic acid does not appear to be excreted by the stomach, but it has been found in the milk, bile and perspiration.

Salicylism.—In some individuals a train of symptoms analogous to those of cinchonism, and designated as salicylism, is produced by the use of salicylic preparations. The skin rashes have already been referred to. Perhaps the most frequent of the manifestations is deafness, generally with tinnitus aurium, and these disorders of hearing, as in the case of quinine, have been shown to depend upon congestion of the tympanum, in which ecchymoses and even inflammation may be found. Such symptoms, it is well to note, may be relieved by the administration of a small amount of alcoholic stimulant fifteen minutes before each dose. The eye may also be affected; so that there may be dimness of vision, sometimes amounting to total blindness, in consequence, it is supposed, of constriction of the ocular vessels. Headache, with a sense of fullness, is also a common symptom, and this is very often associated with epistaxis. In some instances hæmorrhages from the retina, mouth, intestine, kidney, or uterus likewise occur. Abortion has been repeatedly observed under salicylate treatment, but, as in the case of quinine, it is considered an open question whether this was due to the remedy or the disease. If the administration of the drug is continued, the disturbances of the circulation of the brain may produce violent delirium. Nausea and vomiting occur, and the pulse and respiration gradually become depressed. That some at least of these untoward symptoms, as well as others which are occasionally met with, may be due to impurities present in artificial salicylic acid seems probable.

THERAPEUTICS OF SALICIN, SALICYLIC ACID, AND THE SALICYLATES.

External.—For external applications salicylic acid has the advantages of being odorless and comparatively free from the danger of toxic symptoms following absorption. A 10 to 15 per cent. ointment may be used when an antiseptic and stimulating application is called for. Other useful preparations are a collodion composed of salicylic acid, 1; flexible collodion, 8; a glycerin containing 10 per cent. of salicylic acid; and a plaster, also 10 per cent. Strong applications of salicylic acid are very serviceable for removing excess of epidermis, as in warts or corns, because it softens epithelium. The acid has a peculiar action upon the epidermis, and especially upon the corneous layer; the horny cells are softened, gradually loosened, and separated from the corium without any inflammatory reaction. What is known as "green solution," consisting of salicylic acid, 11; extract of cannabis indica, 2; flexible collodion, 87 parts, is often used for corns. Strong applications of the acid are also employed for the destruction of such growths as lupus nodules. Salicylic acid may be combined with chalk as a dentifrice, and with chalk, talc, starch, cornmeal or rice flour for checking profuse or fetid perspiration of the feet and axillæ and also the night-sweats of phthisis. This acid is the principal ingredient in Thiersch's solution (*see* p. 77), and a small amount of it is often added to Thompson's fluid (*see* p. 77). In gangrene or sloughing ulcer it may be applied either in full strength or diluted, as seems advisable. Aqueous solutions, made by means of alcohol, act as a local anodyne, when applied in thrush and catarrhal stomatitis, allaying the burning pain of the erosions left after the vesicles have ruptured. Salicylic acid is used to a considerable extent in cutaneous diseases. On account of its germicidal activity it is efficacious in tinea circinata, and a solution of it in collodion is said to be a serviceable application for scabies, after the skin has been cleansed by a hot alkaline bath. An ointment containing it may be used to remove freckles, and for the treatment of chronic eczema, lupus erythematosus of the face and eyelids, and ulcerated lupus vulgaris. To relieve the smarting and itching of urticaria the following powder has been recommended: Salicylic acid, 5; zinc oxide, 15; powdered starch, 30 parts.

Internal.—In many cases of **rheumatic fever** salicylic acid seems to act as a **specific.** Under its influence the temperature is rapidly reduced and the swelling and pain in the joints diminished, and it apparently has some effect in preventing the cardiac complications so frequently met with in this disease. In order to avoid gastric disturbance it should be administered well diluted. Sodium salicylate is frequently given on account of its greater solubility, in preference to the acid itself. When this preparation is used, care should be taken that it is made either from natural salicylic acid or from artificial acid known to be free from impurities. In a well-marked attack of the disease it is customary to give 1.20 gm. (20 gr.) every two to three hours for the first day, or longer if there is not a satisfactory abatement in the symptoms. When this has been accomplished, the remedy, in the same dose, should be given three times a day, and continued for about ten days after the fever and pain have gone. Salicin, which is usually very well borne and is thought to be less depressant, is less certain in its effects, as its therapeutic activity probably depends upon its conversion into salicylic acid, and this process has been found to be a slow and imperfect one. The salicylic preparations are sometimes of service in chronic as well as acute rheumatism. They are of no benefit in rheumatoid arthritis. In gout their value is questionable, some authorities advocating their employment and others believing them to be entirely inefficient. If given at all in this disease, very large doses seem to be required, and even then no effect may be produced. For the glycosuria of patients affected with gout or goutiness they are distinctly useful. In many cases of migraine and sciatica the salicylates are of incontestible service, and their efficacy in such affections is explained by the action of these remedies in eliminating uric acid. So far as they limit intestinal fermentation they are also beneficial in diabetes. Except in the case of rheumatic fever they are not employed as antipyretics, as in other febrile conditions the temperature can be more efficiently reduced, when this is desirable, by other means. In cases of alkaline urine and cystitis, salicylic acid has sometimes been resorted to to alkalize the urine, but there are better remedies for this purpose. In the treatment of cholelithiasis, sodium salicylate, in association with sodium benzoate, has been found very useful for the conditions which tend to cause intestinal catarrh and thus lead to catarrh of the biliary passages. Salicin, which, like other bitters, promotes appetite and digestion, may be employed as a stomachic in atonic dyspepsia. It has also been found useful in preventing the fermentation which takes place in the food in cases of gastro-intestinal catarrh, and as a remedy for the chronic diarrhœa of children.

OLEUM BETULÆ.—Oil of Betula. (Oil of Sweet Birch.) **Dose, 1 c.c. (15 ♏).**

OLEUM GAULTHERIÆ.—Oil of Gaultheria. (Oil of Wintergreen.) **Dose, 1 c.c. (15 ♏).**

Preparation.

Spiritus Gaultheriæ.—Spirit of Gaultheria. **Dose, 2 c.c. (30 ♏).**

METHYLIS SALICYLAS.—Methyl Salicylate. **Dose, 1 c.c. (15 ♏).**

Preparation.

Cataplasma Kaolini.—Cataplasm of Kaolin.

ACTION OF OIL OF BETULA, OIL OF WINTERGREEN AND METHYL SALICYLATE.

The action of these substances is the same as that of salicylic acid. When taken in moderate quantities, they are, like that acid, broken up and eliminated as salicyluric acid. It is asserted that methyl salicylate, which is an ester, formed synthetically, can be produced of more uniform quality and is more certain and definite in its action than either of the natural oils.

THERAPEUTICS OF OIL OF BETULA, OIL OF WINTERGREEN AND METHYL SALICYLATE.

The uses of these drugs are the same as of salicylic acid, and they possess the additional advantage that they are not liable to contamination with impurities such as ortho- and para-creosotic acids; the former of which is a powerful cardiac depressant, and both of which may possibly be found in the artificial salicylic acid.

PHENYLIS SALICYLAS.—Phenyl Salicylate. (Salol.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

ACTION OF PHENYL SALICYLATE.

Phenyl salicylate is an antiseptic, germicide and antipyretic. It has little or no local action in the mouth or stomach, but in the intestine is decomposed by the fat-splitting ferment of the pancreatic juice into phenol, about 36, and salicylic acid 64, per cent. It is thought that under certain conditions some decomposition also takes place in the stomach. The two constituents, thus set free, are absorbed and produce their characteristic effects on the system. It is not generally toxic in therapeutic doses, but its too free use may give rise to the symptoms of carbolic acid poisoning. In moderate quantities it sometimes produces the disturbances of hearing observed under salicylic acid, without any evidences of phenol intoxication. In large doses the urine may indicate such poisoning.

THERAPEUTICS OF PHENYL SALICYLATE.

External.—As an antiseptic for external use it has probably been overrated, as it is stated to be active only when decomposed by the microbes which it is designed to destroy. It has been used, mixed with talc (1 to 5), as a dusting powder, and as a dressing for wounds, burns and ulcers, as well as for erysipelas, impetigo, pustular eczema, and other cutaneous affections.

Internal.—In rheumatic fever it is used to some extent as a substitute for salicylic acid. Although somewhat slower in action, it has the advantage of being tasteless and of producing no gastric irritation. Occasionally, however, the considerable amount of phenol freed by its decomposition has induced troublesome symptoms. Since the decomposition of salol takes place in alkaline fluids, it has been used as an intestinal antiseptic in acute diarrhœa, catarrh of the bile-ducts, dysentery, cholera and other diseases; also in affections of the urinary tract. It is a remedy of very great value in the treatment of typhoid fever, for by the active disinfection of the contents of the intestine and of the ulcerations, it favors their healing and prevents reïnfection, thus lowering temperature and diminishing the liability to relapse and to permanent damage to tissues. This is the logical treatment, because it destroys the cause of the symptoms at their point of origin. On account of the phenol which it contains, salol is more dangerous than the corresponding amount of salicylic acid, and it is especially to be used with great caution if the kidneys are diseased. Sometimes, in fever, on account of the lessened alkalinity of the intestinal contents, it is not decomposed into its constituents, and for that reason becomes very much less effective. In this case an alkali should be administered at the same time. Phenyl salicylate has proved efficient in the so-called bilious form of sick headache and in some varieties of neuralgia, and is highly praised in the treatment of epidemic influenza.

Unofficial Preparation.

Salophenum.—Salophen. (Acetylparamidophenol Salicylate.) **Dose, .30 to 1 gm.; 5 to 15 gr.**

ACTION OF SALOPHEN.

Salophen is regarded as possessing the medicinal virtues of salol, while at the same time free from its toxic qualities. In a warm alkaline solution it is broken up into salicylic acid and acetylparamidophenol, the latter being harmless. It is decomposed in the intestines, even when given hypodermatically.

THERAPEUTICS OF SALOPHEN.

It is used as a substitute for salicylic acid in acute rheumatism, and as an intestinal antiseptic. It is probably quite as efficient, and much safer than phenyl salicylate. The fact that it is tasteless renders it easy of administration.

DIVISION X.—DRUGS ACTING ON THE NERVOUS AND MUSCULAR SYSTEMS.

A. Drugs acting on the Muscles.—While many facts of interest have been ascertained in regard to this class of drugs, they have no practical bearing on therapeutics. The following classification, founded on that of Kobert, gives the results of investigation:

Class I. *Irritability of muscle unaffected; total amount of work it can do diminished.*—The following produce this effect: Apomorphine, copper, zinc, and cadmium, and in large doses, antimony, arsenic, platinum, and iron.

Class II. *Both the irritability and the capacity for work diminished.*—The following produce this effect: Potassium, lithium, ammonium, quinine, alcohol, hydrated chloral, and chloroform.

Class III. *Diminish the capacity for work, and make the excitability very irregular.*—Lead, emetine, and cocaine.

Class IV. *Alter the form of the muscle curve.*—Veratrine, digitalis, squill, and barium, strontium and calcium salts.

Class V. *Increases the excitability.*—Physostigmine.

Class VI. *Increase the capacity for work.*—Caffeine and theobromine.

Small doses of strychnine and veratrine shorten the latent period; large doses lengthen it.

Dilute alkalies diminish the extensibility; dilute acids increase it.

B. Drugs acting on the Peripheral Endings of Motor Nerves.—Curare is the typical drug of this class. While many of the others have a special action on the motor nerve terminations in common with curare, in the greater number of them this action is more or less over-shadowed by other effects. With curare, however, the action is so widely distributed that it may be looked upon as a peculiar expression of fatigue and as a sign of injury to these endings. In experiments upon animals it can be shown by a process of exclusion that curare paralyzes the peripheral endings of motor nerves alone, the sensory nerves and the muscle-fibres being unaffected.

Drugs paralyzing the termination of the motor nerves in muscle:

(1) Curare.
(2) Conium.
(3) Belladonna (atropine).
(4) Stramonium.
(5) Hyoscyamus.
(6) Scopola.
(7) Sparteine.
(8) Amyl nitrite.
(9) Diluted hydrocyanic acid.
(10) Cocaine.
(11) Camphor.
(12) Lobeline.
(13) Methyl-brucine.
(14) Methyl-cinchonine.
(15) Methyl-codeine.
(16) Methyl-morphine.
(17) Methyl-quinine.
(18) Methyl-nicotine.
(19) Methyl-strychnine, and many others.

Curare and conium are by far the most important, but this action is not made use of in medicine.

Drugs stimulating the termination of motor nerves in muscle:

(1) Aconite.
(2) Nicotine.
(3) Pilocarpine.
(4) Strychnine (slightly).

It is possible that some of the beneficial action of strychnine in certain cases may be due to its slight action on motor nerves, but otherwise these drugs are not employed for this action.

C. Drugs acting on the Peripheral Endings of Sensory Nerves (other than those of special sense).—As it is very difficult to secure any satisfactory data regarding sensation from animals, our knowledge of the action of this group is necessarily derived almost entirely from observations on man.

Drugs which Stimulate the Termination of Sensory Nerves.—These are the same as those already enumerated (p. 297) as acting locally on vessels. When topically applied they give rise to pain, and in the case of most of them the cause of the pain is the local inflammation they set up.

Therapeutics.—It is for their action on the blood-vessels that local irritants are principally used, but they are not infrequently employed also for their counter-irritant effects. By their application to the skin it is probable that changes are induced in the calibre of the vessels and in the sensory nerves of internal organs, so that deep-seated pain is thereby relieved. The heart and respiration are also reflexly stimulated by peripheral excitation of nerves, and hence counter-irritation is made use of to rouse persons who have fainted or became unconscious from opium poisoning, etc. It is essential that the action should be a prompt one, and the application of the faradic current is quite commonly employed as an external stimulus in such cases.

Drugs which Depress the Terminations of Sensory Nerves.—Of these there are two kinds: those which simply relieve pain, or **local anodynes**; and those which diminish sensibility, or **local anæsthetics.**

Local Anodynes.—These have no action unless pain be present. They are—

(1) **Aconite.**
(2) **Phenol.**
(3) **Menthol.**
(4) **Diluted hydrocyanic acid.**
(5) **Veratrine.**
(6) **Ether.**
(7) **Alcohol.**
(8) **Chloroform.**

These must be allowed to evaporate.

(9) **Hydrated chloral.**
(10) **Belladonna.**
(11) **Stramonium.**
(12) **Hyoscyamus.**
(13) **Scopola.**
(14) **Opium.**
(15) **Sodium bicarbonate.**
(16) **Zinc oxide.**

In the above list the most powerful are placed first. The local anodyne action of opium has been disputed, and it is probable that many substances not included in this list which have been regarded as local anodynes have little if any claim to this designation. Cold is an effective local anodyne because of its depressant effect on sensibility, and so likewise is warmth, which relieves pain by diminishing tension, in consequence of the vaso-dilation which it primarily induces.

Therapeutics.—Local anodynes, it may readily be supposed, are called for in a great variety of conditions, and while often of service as adjuvants to internal treatment, they are especially useful in those affections in which it is not possible to remove the cause of the pain or irritation present.

Local Anæsthetics.—These are **cocaine, eucaine, holocaine, orthoform, phenol,** and **extreme cold,** whether produced by ice or by the evaporation of ethyl chloride, or ether. As regards the performance of operations, the ether spray has the disadvantage of stiffening the parts so that it is only useful for a single incision as for opening furuncles. Upon a damp day it is ineffectual. Ethyl chloride sprayed from tubes by the heat of the hand is the best method and the one most frequently employed at present. Eucaine and cocaine, which produce a high degree of local insensibility, are largely employed.

D. Drugs Acting on the Trunks of Nerves.—These, if taken for a considerable period, give rise to chronic neuritis, with much augmentation of the areolar tissue and also fatty degeneration of the nerve-fibres. During the earlier stages of the inflammation much pain and tingling are experienced, but later these are replaced by numbness and diminished sensation as the function of the nerves becomes more and more depressed, and finally paralysis, often accompanied by trophic lesions, results. These actions are of pathological, rather than pharmacological, interest, and will be found fully described in works on medicine.

The drugs producing peripheral neuritis are—

(1) **Lead.**
(2) **Mercury.**
(3) **Arsenic.**
(4) **Alcohol.**

E. Drugs Acting on the Spinal Cord.—After the administration of certain drugs it is found that a slight peripheral stimulus will produce such marked reflex action that convulsions will result. When this is due to stimulation of the spinal cord, it is determined in the following way: If the cord is cut across and convulsions are still caused by such slight stimulus, it is evident that these cannot be of cerebral origin, since in that case they would not take place below the point of section. On the other hand, if the drug does not cause convulsions when previously to its injection into the circulation the vessels of the cord have been ligatured, it is inferred that its action is not on the muscles or nerves. Other experiments going to show that the action is on the cord are the following: If when the drug is injected into vessels by which it reaches the cord quickly, convulsions appear sooner than when it is injected into other vessels; if convulsions do not occur when the cord is destroyed; if when the destruction of the cord is gradually produced by pushing a wire down the vertebral canal, the convulsions cease from above downward as the destruction proceeds.

(1) The drugs increasing the irritability of the anterior cornua are—

(1) **Strychnine.**
(2) **Ammonia.**
(3) **Chloroform.**
(4) **Ether.**
(5) **Ergot.**
(6) **Opium.**

(The last four only slightly and early in their action.)

Therapeutics.—Strychnine is at times useful for paralysis resulting from diseases of the spinal cord, but with this exception it is rare that affections of the cord are benefited by stimulation of the anterior cornua.

(2) Drugs which depress the activity of the anterior cornua.

(1) **Physostigmine.**
(2) **Gelsemium.**
(3) **Bromides.**
(4) **Alcohol.**
(5) **Chloroform.**
(6) **Ether.**
(7) **Ergot.**
(8) **Opium.**
(9) **Mercury.**
(10) **Zinc salts.**
(11) **Silver salts.**
(12) **Sodium salts.**
(13) **Potassium salts.**
(14) **Lithium salts.**
(15) **Antimony salts.**
(16) **Arsenical salts.**

Camphor.
Amyl nitrite.
Sodium nitrite.
Hydrated chloral.
Phenol.

(22) **Apomorphine.**
(23) **Veratrine.**
(24) **Turpentine.**
(25) **Emetine.**
(26) **Colchicum.**

se, apomorphine, alcohol, chloroform, ether, arsenic, camphor,
phenol, hydrated chloral, and veratrine first excite slightly
pressing.

eutics.—So far as their action on the spinal cord is
d, these drugs are of very little practical utility. Phys-
e, which is by far the most powerful, has been tried to
rable extent in tetanus and other diseases accompanied
lsions, but with little benefit.

gs Acting on the Brain.—The action of these can by
be so distinctly localized as that of drugs acting on
l cord and nerves. Drugs acting on the brain illus-
very important general laws:

ne **law of dissolution,** which, when stated as it applies
acology, is as follows: When a drug affects functions
vely, those first affected are the highest in develop-
t is to say, they are the last acquired by the individual
ast to appear in the species. The next affected are
xt to highest, and so on; till finally the lowest of all
evolutionary point of view, that is to say, the functions
ation and circulation, are affected. This law is well
ed in the case of alcohol, under the influence of which
functions to be disordered are those of the intellect,
especially the highest, such as judgment and reason; then follow disorders of movement, and finally death from failure of respiration and circulation.

(2) When a drug in **moderate** doses **excites** a function, in **large** doses it often **paralyzes** it. Cerebral stimulants may thus also be hypnotics.

Drugs Acting on the Motor Centres of the Brain.—To investigate these, the motor area of the cortex is exposed by trephining. One method is to note, before and after the administration of the drug, the strength of the electric current which it is necessary to apply to this area to produce corresponding movements. Another is to observe the strength of current necessary to elicit a movement and then to allow the wound made by the trephine to close; after which the drug is regularly administered to the animal for several weeks. The opposite motor area is then exposed, and the strength of the current required for the same purpose is noted.

It has been found that the following diminish the activity of the motor area.

(1) **Alcohol.**
(2) **Anæsthetics.**
(3) **Hydrated chloral.**
(4) **Potassium bromide.**
(5) **Sodium bromide.**
(6) **Ammonium bromide.**

It is on account of this action that bromides are largely employed in epilepsy and other convulsive affections.

Drugs exciting the motor cells of the cortex are—

(1) **Atropine.**
(2) **Strychnine.**
(3) **Physostigmine.**

They are not used in medicine for this purpose.

(1) *General Cerebral Stimulants.*—Experiments on animals are of no value in determining the effects of these. In the human subject they produce general excitation of the mental faculties, and this is not infrequently followed by confusion, incoherence and delirium, the character of the latter varying to some extent with the particular drug employed. In many instances the stimulation is soon replaced by a paralyzing influence.

Such drugs are—

(1) **Belladonna.**
(2) **Stramonium.**
(3) **Hyoscyamus.**
(4) **Scopola.**
(5) **Alcohol.**
(6) **Chloroform.**
(7) **Ether.**
(8) **Coffee.**
(9) **Tea.**
(10) **Guarana.**
(11) **Coca.**
(12) **Cannabis Indica.**
(13) **Lupulin.**
(14) **Opium.**
(15) **Camphor.**
(16) **Santonin.**
(17) **Quinine.**
(18) **Salicylic acid.**

Therapeutics.—These are of the greatest importance in their therapeutic applications, and many of the drugs are taken habitually as cerebral stimulants in various parts of the world.

(2) *General Cerebral Depressants.*—These are commonly divided into three classes: Hypnotics or Soporifics, Narcotics and Anæsthetics.

HYPNOTICS OR SOPORIFICS are drugs which produce sleep, closely resembling, if not identical with, natural sleep. It is known that during sleep the brain is anæmic, and it is probable that the anæmia is the cause of sleep. It may be that the action of some hypnotics is due to their inducing cerebral anæmia.

The hypnotics are—

(1) **Opium.**
(2) **Morphine.**
(3) **Hydrated chloral.**
(4) **Chloralformamide.**
(5) **Bromides.**
(6) **Sulphonethylmethane.**
(7) **Sulphonmethane.**
(8) **Paraldehyde.**
(9) **Alcohol.**
(10) **Hyoscine.**
(11) **Scopolamine.**
(12) **Cannabis Indica.**
(13) **Urethane.**
(14) **Lupulin.**
(15) **Lactucarium.**

Therapeutics.—In all cases of insomnia the underlying condition should be carefully looked into and removed if possible. These drugs should be resorted to with the greatest reluctance on account of the danger of habituation. Chloral, if used with great caution, paraldehyde, sulphonethylmethane, and choral-formamide are perhaps the most satisfactory, but the use of hypnotics is apt to be greatly abused. It is well to remember that sleep may often be induced by causing dilatation of the vessels of other parts of the body than the brain. Thus, a warm bath or a full meal tends to promote sleep.

NARCOTICS are substances which not only produce sleep, but also in large doses depress the functions of respiration and circulation. Many of them fall also under the head of general anæsthetics; others are, in smaller doses, hypnotics. All must be given in considerable doses.

The following is a list of them.

(1) **General Anæsthetics.**
(2) **Opium.**
(3) **Hydrated chloral.**
(4) **Belladonna.**
(5) **Stramonium.**
(6) **Hyoscyamus.**
(7) **Scopola.**
(8) **Alcohol.**
(9) **Cannabis Indica.**
(10) **Lupulin.**

Therapeutics.—They are of great value in diminishing morbidly acute perception, relieving pain, allaying irritation, nervous excitability, and spasm, inducing sleep, and regulating the vital functions by rest. For instance, opium and belladonna are sometimes of much service in cardiac disease.

GENERAL ANÆSTHETICS.—These are drugs which lead to a total loss of consciousness, so that pain is no longer felt, while at the same time reflex action is abolished. They illustrate admirably the law of dissolution, and also the fact that, after excitement, paralysis often succeeds. The various stages of their action will be described under Chloroform and Ether.

There are individual differences in the different anæsthetics, and different individuals are sometimes differently affected by the same anæsthetic.

(3) The general anæsthetics are—

(1) **Chloroform.**
(2) **Ether.**
(3) **Nitrous oxide.**
(4) **Many other substitution products** derived from alcohols and ethers.

Therapeutics.—Anæsthetics are given to cause unconsciousness, so that pain may not be experienced during operations, to relax muscles in cases of dislocations, abdominal examinations, phantom tumors, etc., to relieve severe pain, such as that of parturition, biliary and renal colic, and to control convulsions, as in tetanus and hydrophobia.

The chief dangers of anæsthetics are—1. Death from shock. This usually takes place before the patient is fully under the influence of the anæsthetic; reflex action being not yet quite abolished, the heart is stopped reflexly in consequence of the peripheral stimulus of the operation. Such a deplorable result may generally be avoided by taking care that the patient is fully under the influence of the anæsthetic before the operation is begun.

2. Death from paralysis of respiration. This may be due to various circumstances. Thus, too much of the anæsthetic may have been given, the patient may be suffering from some disease of the lungs which renders respiration difficult, or the operation may demand a posture which interferes with the breathing. It is not usually a very grave danger, as warning is afforded by the lividity of the surface. Changing the posture and the withdrawal of the anæsthetic are often all that is required to restore the patient, but artificial respiration, with the head thrown back and the tongue pulled forward, may be called for, and in some instances it is necessary to maintain this for hours.

3. Cardiac failure may occur if the vapor is too concentrated. Gradual heart-failure is always preceded by respiratory changes, but cardiac arrest may occur suddenly and without warning. The patient all at once grows pale, and the pulse stops. In such a case the anæsthetic should be discontinued, the patient should be placed in the inverted posture, and artificial respiration maintained as before. The heart may be stimulated by large rectal injections of hot normal saline solution or of coffee, if at hand, by the inhalation of amyl nitrite, by the plunging of electric needles into the heart or, better, by making a series of forcible compressions of the chest over the heart; also, if the reflexes are not abolished, by flicking the chest over the heart with hot towels and placing hot compresses over it. Giving brandy subcutaneously is to but add the effect of one poison to that of another. The application of the faradic current over the cardiac region is also objectionable.

4. Vomited matter or, if the operation is about the mouth, blood, may suffocate the patient. No food should be taken for some time before the operation, and if the patient is sick at the stomach, he should be turned on his side. In operations about the mouth special precautions are required.

G. Drugs Acting on the Eye.

1. Drugs Acting on the Pupil.—If when a drug having the property of dilating or contracting the pupil is applied locally to one eye, it acts promptly and powerfully, and only upon the

eye into which it is dropped, it is evident that its action must be local. So also when it acts on an excised eye. Again, if the drug will act when thrown into the eye after all the vessels going to the eye are ligatured, but will not act when thrown into the general circulation, its action is shown to be local. On the other hand, if after being dropped into one eye it acts but feebly and after some time upon both eyes, it is to be inferred that its action is a central one. So, if all the vessels of the eye are ligatured, and the drug will not act if dropped in the eye, although it would do so if thrown into the general circulation, it is proved to act centrally. If such a drug acts when locally applied, the inference is that its action is due to the fact that some of it has been absorbed.

As to the manner in which a centrally-acting drug exerts its influence, it has been shown that it may act either upon the muscular fibres of the iris, upon the terminations of the third, or motor oculi, nerve in these fibres, or upon the terminations of the cervical sympathetic in them. Stimulation of the third nerve causes the pupil to contract and stimulation of the cervical sympathetic causes it to dilate; while section of these nerves produces just the opposite effects. If, when the pupil is dilated by the local action of a drug, stimulation of the third nerve will not cause contraction, notwithstanding the muscular fibres are responsive to mechanical stimulation, it shows that the terminations of the third nerve are paralyzed. If, on the other hand, the pupil is contracted by the drug, and although responsive to mechanical stimulation, will not dilate after section of the third nerve, it shows that the terminations of this nerve are stimulated. If a drug, locally applied, causes dilatation of the pupil, but not to the same extent as is caused by stimulation of the sympathetic, it is shown that its whole effect is not due to stimulation of the sympathetic; and if the muscle remains locally irritable, there must be paralysis of the terminations of the third nerve. In a similar way the actions on the sympathetic may be determined. It has been found, however, that many drugs act both on the third nerve and on the sympathetic, and in the following list they are classified under their main actions:

Mydriatics (dilate the pupil)—

A. Paralyze the termination of the third nerve.

(1) **Atropine.**
(2) **Homatropine.**
(3) **Hyoscyamine.**
(4) **Coniine.**
(5) **Gelsemine.**
(6) **Hydrocyanic Acid.**
(7) **Aconite.**
(8) **Amyl nitrite.**
} probably.

B. Stimulate the terminations of the sympathetic.—**Cocaine.**
C. Act centrally.—**Anæsthetics** (late in their action).

Myotics (contract the pupil).

A. Stimulate the terminations of the third nerve.—**Pilocarpine,** and **nicotine** (probably).
B. Stimulate the muscle.—**Physostigmine.**
C. Act centrally.—**Anæsthetics** (early in their action) and **Opium.**

Therapeutics.—Dilators of the pupils, especially atropine and homatropine, are used to dilate the pupil for ophthalmoscopic examination, and to prevent or break down adhesions of the iris. Contractors of the pupil, especially physostigmine, are used to overcome the effects of atropine, to prevent or break down adhesions of the iris, and to prevent too much light entering the eye in painful diseases of the organ.

2. Drugs Acting on the Ciliary Muscle.—The following drugs impair or paralyze accommodation:

(1) **Atropine.**
(2) **Hyoscyamine.**
(3) **Homatropine.**
(4) **Cocaine.**
(5) **Physostigmine.**
(6) **Pilocarpine.**
(7) **Gelsemine.**
(8) **Coniine.**

Intra-ocular tension is increased by atropine (large doses) and hyoscyamine. It is decreased by cocaine, hyoscine, and physostigmine.

Gelsemine paralyzes the external ocular muscles, especially the levator palpebræ and the external rectus, by its action on the terminal nerve filaments.

Cocaine, by stimulating the unstriped fibres in the orbital membrane and the eyelids, causes the eye to protrude. Coniine, when given in large doses, produces ptosis.

The capacity for seeing blue is increased by strychnine. Santonin causes first violet, then yellow vision.

H. Drugs Acting on the Ear.—Very little is known of the action of drugs upon the organ of hearing. Some substances, such as quinine and salicylic acid, cause ringing and buzzing in the ears, and sometimes deafness.

I. Drugs Acting on the Sympathetic System.—The principal points in regard to the actions of drugs on the sympathetic system have already been touched upon in discussing their actions upon blood-vessels.

B. Drugs Acting on the Peripheral Endings of Motor Nerves.

CURARE.

Curara.—Curare (unofficial). (Wourara. Ourari. Urari. Wourali.)
Dose, 0.0025 to 0.03 gm.; $\frac{1}{25}$ to $\frac{1}{2}$ gr.

Action of Curare.

The characteristic effects of curare are **paralysis** of the **nerve endings** in striped muscles and, later, paralysis of the nerve endings around sympathetic ganglia. Under very large doses there is induced a direct **depression** of the irritability of the **muscle substance.** In some instances tetanic convulsions, from an action on the central nervous system, are caused before the characteristic curare action makes its appearance, but under ordinary conditions, and especially if the amount given is only moderately large, these are masked by the paralysis of the nerve endings. When curare is applied directly to the spinal cord, it gives rise to typical strychnine convulsions. It is eliminated chiefly in the urine, but some of it appears also in the fæces. The urine of a curarized animal will poison another one, and this may be repeated to several animals.

Therapeutics of Curare.

It has been used, by hypodermatic injection, with a limited measure of success in tetanus. In epilepsy some observers have found it beneficial, and it has been experimented with in the treatment of various other nervous affections. In practice it has proved unsuccessful as an antidote in strychnine poisoning.

CONIUM.

CONIUM.—Conium. (Spotted Hemlock.) **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

Preparation.

Fluidextractum Conii.—Fluidextract of Conium. **Dose, 0.2 c.c. (3 ♏).**

ACTION OF CONIUM.

External.—It has no action on the unbroken skin. When applied to bruised surfaces it has been alleged to exert something of an anæsthetic influence, but, in view of the manner of action of the drug, very large doses being required to produce a depressant effect upon the sensory nerves, this seems improbable.

Internal. *Gastro-intestinal Tract.*—Coniine, even when injected directly into the circulation, causes nausea and frequently vomiting at an early stage of its action, and this effect is no doubt due to a medullary influence. The nausea is accompanied by profuse salivation and sometimes by perspiration. Large doses by the mouth may produce some diarrhœa, as well as vomiting.

Circulation.—The cardiac action is not marked. As the inhibitory mechanism is stimulated, the pulse is usually rather slow and weak. Sometimes, however, paralysis of the ganglia on the inhibitory nerve may cause its acceleration. A considerable, though transient, increase in the arterial tension which is observed has been attributed to a stimulation of the ganglionic apparatus situated in the course of the vaso-constrictor nerves.

Respiration.—The respiration is at first quickened and deepened, but later becomes slow and labored, and then weak and irregular. It finally ceases while the heart is still strong, and the asphyxia is believed by the majority of recent investigators to be due to paralysis of the nerve endings in the diaphragm. Many, however, consider that the respiratory centre in the medulla is paralyzed before these terminations.

Nervous System.—In the frog the chief effect is a paralysis of the motor nerve terminations, such as is caused by curare, but it is thought probable that while in frogs the symptoms are all due to the action on the nerve endings, in mammals, in whom this paralysis is much less marked, some of the phenomena observed are due to central stimulation and to subsequent paralysis of the respiratory centre. On the nerve terminations in ganglia coniine acts in the same way as curare. It is found that after large doses of the drug the inhibitory impulses, owing to paralysis of the ganglionic apparatus, no longer reach the heart, and that stimulation of the vagus nerve has no effect on the pulse-rate. Weak convulsive movements are often observed before death, but they are due simply to the asphyxia.

In the earlier stages of the intoxication, twitchings and tremors may occur. While coniine has been supposed to have a narcotic depressing action on the central nervous system, this is by no means a characteristic feature of its effects. Languor and drowsiness are observed, but the latter does not pass into actual sleep. In both man and animals consciousness is generally retained until immediately before the cessation of respiration, and in most cases the intelligence remains clear to the end, as in the case of Socrates.

In man the main symptoms relate to the motor system, and these are very characteristic. Under poisonous doses there is an ascending paralysis, beginning with the lower extremities and finally reaching the tongue, so that the patient may be unable to speak, though his intellect remains unimpaired. This ascending paralysis has been ascribed to a lowered conductivity of the spinal cord to impulses coming from the brain, the path being blocked at first only to those impulses which have a long distance to traverse. The sensory, as well as the motor, nerves are depressed.

Eye.—In coniine poisoning the pupils are generally somewhat dilated, and ptosis also occurs, indicating that the dilatation is due to oculo-motor paralysis. In many instances imperfect vision, from paralysis of accommodation, is noted.

Excretion.—Coniine is excreted in the urine, and very rapidly, so that its action passes off quite soon even when a considerable quantity has been taken.

THERAPEUTICS OF CONIUM.

External.—Hemlock leaves, in the form of poultices and ointments, have been applied to painful swellings and ulcers, but are of doubtful benefit. Conium applications for the relief of myalgia or rheumatic pains are quite useless.

Internal.—Conium has fallen into almost complete disuse, and one reason for this is the unreliability of its preparations, which may contain no coniine whatever. This substance is very volatile and unstable, and light and air render it inert. Conium has been employed in spasmodic affections, as chorea, paralysis agitans, tetanus, epilepsy, whooping-cough, asthmatic attacks and laryngismus stridulus, and also in maniacal and hysterical excitement. It has little value except in spasms due to irritation of a nerve-trunk, when it may perhaps be of service. In those of cortical or spinal origin other remedies should certainly be employed, as the physiological action of the drug shows that it has really very little quieting effect upon the central nervous system, but only prevents the impulses which are sent out from manifesting themselves in movements of the muscles.

TOXICOLOGY.

Attention has already been called to the languor and drowsiness and to the eye-symptoms in cases of poisoning. The other phenomena have been so accurately described by Plato in his account of the death of Socrates, who was probably given the expressed juice, that his words may be taken as a fair representation of the ordinary symptoms: "He went about, and as he noticed that his thighs became heavy, he lay down on his back, as the man directed. The latter—the one who had given him the poison—touched him from time to time, and examined his feet and thighs. Then he pressed his foot strongly, and asked whether he could feel it; he answered, No. Then he tried the knees, and so went higher and higher, and showed us how he gradually became cold and stiff. Then he touched him once more, and said that when it came to the heart he would be dead. Now almost everything from the abdomen down was cold." The mental powers of the sage remained unimpaired until near the end. *Post-mortem.*—No distinctive lesions are found, but only the usual indications of death from asphyxia, such as engorgement of the organs with venous blood.

Treatment.—Emetics (*see* p. 159) should be administered and the stomach washed out. Then tannic acid should be given freely, and the stomach again washed out. Strychnine, as a respiratory stimulant, and other stimulants, by hypodermatic injection, are called for. Warmth should be applied to the surface and artificial respiration resorted to.

LOBELIA.

LOBELIA.—Lobelia. (Indian Tobacco.) **Dose, 0.5 gm. (7½ gr.).**

Preparations.

1. **Fluidextractum Lobeliæ.**—Fluidextract of Lobelia. **Dose, 0.5 c.c. (8 ♏).**
2. **Tinctura Lobeliæ.**—Tincture of Lobelia. **Dose,** (expectorant) **1 c.c. (15 ♏)**; (emetic) **4 c.c. (1 fl. dr.).**

ACTION OF LOBELIA.

External.—Lobelia is absorbed through the skin, but has no local action on it. The local application of lobeline to the eye is followed by contraction of the pupil, though in general poisoning by it dilatation has been observed.

Internal. *Gastro-intestinal Tract.*—Lobelia is a powerful **gastro-intestinal irritant.** Ordinarily, however, it produces violent vomiting without any action on the bowels, as most of it is expelled by the emesis, which is attended by extreme prostration. When the vomiting is insufficient to get rid of the poison it causes active purging, and **collapse** is **marked.** When injected into animals lobeline induces vomiting and salivation, these effects being ascribed to stimulation of the medullary centres.

Circulation.—In consequence of its action on the inhibitory apparatus of the heart, the pulse-rate is slowed at first, but afterwards is more or less accelerated. The blood-pressure, at first diminished, is afterwards increased beyond the normal. As a result of vomiting, however, marked variations in the rate of the heart and in the arterial tension are apt to be observed. In the collapse resulting from the gastro-intestinal irritation caused by lobelia the pulse is naturally small and weak.

Respiration.—Small doses stimulate and large doses paralyze the respiratory centre, while the **vagus terminations** in the muscular coat of the bronchi or in ganglia in the lungs are also **paralyzed** by lobeline. The respiratory movements may at first be much increased in rate and force. Later they become dyspnœic and asphyxia supervenes, death occurring from **respiratory failure.**

Nervous System.—When injected into mammals lobeline induces increased reflex irritability, as well as accelerated respiration. The same is true as regards frogs, so that it is inferred that in both it causes primary stimulation of the spinal cord and of the medulla oblongata. Only in the frog, however, does there appear to be any action on the higher divisions of the nervous system. They are depressed in frogs and in them the terminations of the motor nerves are paralyzed in the same manner as by curare. In man, and warm-blooded animals generally, coma and convulsions may be observed after poisonous amounts, but they would seem to be simply a result of the asphyxia. By some, however, these effects are regarded as due to a direct action on the higher cerebral centres.

Excretion.—Lobelia is apparently excreted by the kidneys and to some extent by the skin, and it is credited with a diuretic and diaphoretic action.

THERAPEUTICS OF LOBELIA.

External.—As an external application tincture of lobelia, with an equal quantity of glycerin, is a most useful remedy for the relief of pain in acute epididymitis.

Internal.—As it has the effect of relaxing bronchial muscle, the chief use of lobelia is for the relief of the symptom asthma. The administration of .6 c.c. (10 ♏) every ten minutes, if begun early, often shortens the paroxysm. Lobelia is also employed to some extent as an expectorant in bronchitis, and especially when the latter is characterized by a spasmodic element. It is often combined with other antispasmodics and expectorants. In both bronchitis and asthmatic attacks its good effects are no doubt largely due to the free secretion of mucus which is produced by its nauseant action. It is, relatively, better borne by children than by adults. It was formerly prescribed as an emetic and also as a purgative, but it is now regarded by most as too depressing to be used for these purposes, while its action as a purgative is very uncertain. In very small doses, however (.06 to .12 c.c.; 1 to 2 ♏ every hour, or .6 c.c.; 10 ♏ at bed-time), the tincture is still recommended by some writers as useful in promoting peristalsis and intestinal secretion in cases of habitual constipation, dependent upon atony of the muscular layer and deficient secretion of the bowel, where there is an impacted cæcum, but no inflammatory action has supervened.

C. Drugs Acting on the Peripheral Endings of Sensory Nerves.

MENTHOL.

MENTHOL.—Menthol. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Action of Menthol.

Menthol is **antiseptic** and **locally anæsthetic**, producing a sensation of coldness wherever it is applied. The blood-vessels of the part are, however, dilated, and instead of there being a fall of temperature, the skin temperature is higher there than elsewhere. The drug is generally regarded as exerting a peculiar stimulating effect upon the nerves conveying the sense of cold, but this has been denied by some authorities, who assert that it acts only on the terminations of the nerves of common sensation or pain. The feeling of coldness is associated with more or less prickling, and later there follows some heat and burning. Like camphor, menthol stimulates the central nervous system, and its general effects are practically identical, except that the convulsions to which it gives rise are much less severe. It is excreted in combination with glycuronic acid.

Therapeutics of Menthol.

Menthol, externally applied, will often relieve neuralgic pains, provided they are of superficial and peripheral origin. The solid menthol, in the form of a cone, is sometimes employed for this purpose, and sometimes it is used in alcoholic solution. A menthol plaster is composed of menthol, 3; yellow wax, 1; rosin, 15; and an excellent liniment, of menthol, 3; chloroform, 4; olive oil, 9. Rubbed up with an equal part of camphor, hydrated chloral, or phenol, and placed in the cavity, it promptly cures the aching of a carious tooth. It has considerable power in controlling superficial inflammations, and in an ethereal solution of from 10 to 50 per cent. may be applied two or three times a day for the purpose of aborting boils, carbuncles, cutaneous abscesses, etc. An excellent combination for inflamed joints, whether the inflammation is rheumatic or gonorrhœal, is a mixture of menthol, thymol and hydrated chloral (each 8 gm.; 2 dr.), rubbed up together until liquefied, and to which are added morphine sulphate, .13 gm. (2 gr.) and atropine sulphate, .008 gm. (⅛ gr.), or cocaine hydrochloride, .06 gm. (1 gr.). Or, a solution of menthol, thymol and hydrated chloral in chloroform may be painted over the inflamed part. These combinations are also applicable in local neuralgias. Menthol is very useful for allaying itching, and is employed in solutions (to which other drugs may be added, if called for), in such affections as pruritus ani, urticaria, eczema and herpes zoster. In laryngeal and tracheal tuberculosis great relief is afforded by a 20 per cent. solution in olive oil, introduced into the larynx as a spray, and followed by inhalations of the same from boiling water or by means of a respirator. In bronchiectasis the injection twice daily of 4 c.c. (1 fl. dr.) of a mixture composed of menthol, 10; guaiacol, 2; olive oil, 88, has been followed by marked improvement. Menthol is now used to a considerable extent topically in diseases of the ear and nose. In the nasal form of hay fever a mixture of menthol and ammonium carbonate has been found to make a very efficient smelling-salt. Internally menthol has been used in small doses (.006 gm.; 1/10 gr.) to relieve nausea and vomiting. In doses of .10 gm. (1½ gr.), in capsules with olive oil (six or eight being taken daily), it has been given as an intestinal antiseptic. In spasmodic cough, asthma and hiccough its internal administration is sometimes of service.

COCA.

COCA.—Coca. (Erythroxylon. Cuca.) **Dose, 2 gm. (30 gr.).**

Preparations.

Fluidextractum Cocæ.—Fluidextract of Coca. **Dose, 2 c.c. (30 ♏).**

Vinum Cocæ.—Wine of Coca. **Dose, 16 c.c. (4 fl. dr.).**

COCAINA.—Cocaine. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

Preparation.

Oleatum Cocainæ.—Oleate of Cocaine.

COCAINÆ HYDROCHLORIDUM. — Cocaine Hydrochloride. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

ACTION OF COCA.

External.—Cocaine has little or no action on the unbroken skin, but upon mucous membranes or the subcutaneous tissue it produces **complete local anæsthesia.** At first, owing to the contraction of the vessels caused, the surface to which it is applied becomes somewhat blanched, but later there is hyperæmia with increased redness of the part, in consequence of secondary vascular dilation. A 5 to 10 per cent. solution of the hydrochloride will paralyze the sensory nerves, but to produce this effect on motor nerves requires a much stronger dose. The local application of cocaine to the tongue abolishes the sense of taste, and to the nose, that of smell. This alkaloid is a typical **protoplasmic poison,** and its effects as a local anæsthetic are no doubt attributable to its destructive action on the protoplasm of the end organs.

Internal. *Gastro-intestinal Tract.*—In South America from time immemorial the natives have chewed coca leaves to relieve hunger and fatigue. On account of its anæsthetic effect on the gastric mucous membrane cocaine deadens the sensation of hunger, and tends to allay irritability of the stomach, but the drug is not an aliment, and if no food is taken, rapid emaciation occurs under its use. In exceptional instances vomiting is caused when poisonous quantities are swallowed. According to some observers intestinal peristalsis is markedly increased by moderate doses, while after large doses this increase is followed by great sluggishness, deepening into paralysis.

Circulation.—The pulse-rate is lessened by very small doses, in consequence of stimulation of the vagus centre, but increased by large doses, which depress the vagus. Usually, but not, it is said, invariably, the heart is eventually slowed, apparently from a direct depressant action on the cardiac muscle. Cocaine constricts the arterioles, mainly from stimulation of the vaso-constrictor centre, and in the earlier stages of the poisoning the vessels are much contracted. This, together with the increased rate of the heart, leads to a marked rise in the blood-pressure. Later the pressure falls, probably from peripheral action.

Respiration.—The respiratory centre in the medulla is at first stimulated and then depressed. Consequently, the respiration is primarily accelerated, but as the depression comes on, the amount of air inspired gradually becomes diminished, and the breathing grows slow, weak and irregular. Cheyne-Stokes respiration is frequently present, and death occurs from **asphyxia.**

Nervous System. Cerebrum.—The first effect is a stimulation of the higher parts of the brain, such as is caused by caffeine. In animals there is increased movement, which is perfectly coördinated, and in man wakefulness and **mental exhilaration.** All observers agree that cocaine has remarkable potency in **increasing muscular power** and removing fatigue. If the quantity taken is sufficiently large, the stimulation is followed by depression, which is often first shown in choreic movements, from derangement of the coördinating functions. The animal moves in a circle, the symptoms resembling the forced movements often seen in affections of the cerebellum. Narcosis ensues, and this is succeeded by convulsions, the seat of which has not been determined, but is supposed to be in some portion of the hind brain. If the paralysis is rapid, it is found that the convulsive stage may be absent.

Medulla Oblongata.—The medulla is early affected, and the various centres are first stimulated and then depressed.

Spinal Cord.—The cord, too, is at first stimulated, as is shown by exaggeration of the reflexes, and very large doses may cause convulsions, of spinal origin, resembling those due to strychnine. It will thus be seen that the action of cocaine on the central nervous system consists in a descending stimulation, followed by depression, which successively progresses from the cerebrum to the spinal cord. In some cases, however, it is to be noted, the stage of stimulation is very short or altogether absent, and it has also been observed that the two stages are not definitely divided, so that one part of the cerebrum may show depression while another is still excited. With small doses the cerebrum chiefly is affected.

Eye.—Cocaine, applied to the eye, causes local anæsthesia and pallor of the conjunctiva and iris, from vascular constriction. When it is applied to the conjunctiva, in considerable quantity and for some time, and also when it is administered systemically, ocular phenomena are produced which are the same as those caused by **stimulation** of the **cervical sympathetic.** It is therefore considered that cocaine has a special action on the centres or terminations of this nerve, and there is reason to believe that the stimulation to which it gives rise really affects both. **Mydriasis** is caused, though the iris still reacts to light, and the **accommodation** is **impaired.** The intra-ocular tension is somewhat reduced, and the palpebral aperture is widened. The dilatation of the pupil differs from that due to atropine as regards the persistence of the reaction to light and in being less complete. The mydriasis is also more readily overcome by pilocarpine and muscarine than that caused by atropine. Either strong or weak cocaine solutions when frequently applied desiccate the corneal epithelium.

Temperature.—Under large doses of cocaine the temperature rises, and this has been ascribed to a stimulation of the thermogenetic centre in the brain. In poisoning in animals it has been observed that the higher the temperature, the more readily are convulsions produced and the more severe their character.

Excretion.—Cocaine is eliminated in the urine and probably also excreted into the intestine. The quantity of urine appears to be sometimes increased and sometimes diminished. In some instances the injection of the drug has been followed by complete anuria lasting for several hours. In view of the variations noted, it has been suggested that the action is not a direct one on the kidney, but is caused merely through the changes in the calibre of the vessels. The effects on the vaso-motor centre, an early stimulation and later paralysis, would account for such variations. The other secretions beside the urinary seem to be rather diminished than increased. Cocaine has some anaphrodisiac effect.

THERAPEUTICS OF COCA.

External.—A 5 to 10 per cent. solution of cocaine hydrochloride may be injected subcutaneously as a local anæsthetic for the performance of small operations. In the infiltration method of Schleich three solutions are employed: cocaine hydrochloride, 0.2 (strong); 0.1 (normal); or 0.01 (weak); morphine hydrochloride, 0.025; sodium chloride, 0.2; sterilized distilled water or saturated boric acid solution to 100. These are injected into the substance of the skin, forming wheals. This method requires less of the drug than when it is used subcutaneously. Yet it should be borne in mind that the anæsthetic properties of the two weaker solutions depend largely upon the mechanical anæsthesia produced by injection of water, the analgesic effect of which had been previously pointed out. Solutions of cocaine hydrochloride, topically applied, are used for operations on the mouth, throat, teeth (4 per cent.), eye (1 to 4 per cent.), ear, vagina, urethra and rectum (4 to 10 per cent.). Congestive urethral stricture may be temporarily relieved by it, so that instruments may be passed, but it should be employed with great care in urethral operations. It is used on mucous membranes for the relief of pain in various conditions, and also for the abatement of inflammation. It is of service in painful ulcers, fissures, etc., and in pruritus of the vulva and anus, and is also used as an application to the nasal passages in coryza and hay fever. In the latter affections a powder consisting of cocaine, 1; morphine, 1; bismuth subnitrate, 5, may be snuffed into the nostrils. Ointments, bougies and suppositories, usually containing 2 to 5 per cent. of cocaine, which mixes better than the hydrochloride, are very useful. A 15 per cent. solution has been injected into the gums for tooth extraction, but is hardly to be commended. Ophthalmic surgeons employ it very largely to produce local anæsthesia of the eye. If inflammation is present, however, anæsthesia is produced with great difficulty.

Internal.—Cocaine, because of its effect in depressing the gastric sensory nerves, is sometimes employed to relieve vomiting in pregnancy, seasickness and other conditions. It or the fluidextract of coca may be given as a stimulant in low fevers, and in cases where great physical and mental strain is to be borne. The preparations of coca, especially the wine, are much used as stomachic tonics, and in the debility of convalescence from acute diseases. Some clinicians have found cocaine a remedy of the highest value in chorea, and state also that paralysis agitans, alcoholic tremors, and senile trembling are more favorably affected by it than by any other drug.

Medullary Anæsthesia.—Within the last few years it has been proposed to obtain surgical anæsthesia by injection of from $\frac{1}{10}$ to $\frac{1}{5}$ gr.; .006 to .012 gm. into the arachnoid space. Puncture is made between the third and fourth lumbar interspace of the spine with a specially prepared needle, as for diagnostic purposes. A few drops of the spinal fluid is allowed to escape and the solution is injected. Anæsthesia supervenes, gradually extending from the feet upwards, and may reach to the chest or even higher; this persists for a variable time, but generally sufficient for the performance of surgical operations. This method of anæsthesia does not interfere with labor further than abolishing its pain. Strict asepsis must be observed. Beyond some nausea, vomiting and headache, after-effects are not usually noticed. Several deaths, however, have now been reported as due to the procedure; so that it seems hardly likely that it will supplant ether or chloroform narcosis, or that it can be performed without too great risk except when contra-indications exist to either of these anæsthetics.

TOXICOLOGY.

Symptoms.—Acute poisoning in quite a large number of instances has followed the injection of cocaine into the urethra previous to some operation, and sometimes occurs from the injection of the drug under the gums or skin. Otherwise it is not often met with. The symptoms vary in different individuals, but usually the patient at first becomes more or less excited, restless and garrulous. The pulse and respiration are quickened, the pupils dilated, and there are present dryness of the throat, headache, vertigo and confusion. There may be exaggeration of the reflexes, and tremors and slight convulsive movements are apt to occur. Later, powerful tonic or clonic convulsions may come on. The heart becomes turbulent in its action, and the respiration, which soon grows dyspnœic in character, may be arrested during a convulsion. In other cases no actual convulsions may be met with, while fainting and collapse rapidly supervene. The patient suffers from profound cardiac and respiratory depression, with tremors, and the skin is cold, cyanotic and clammy. Death may take place from gradual failure of the respiration, and if the patient survives he may suffer for months from tremors and other nervous symptoms. Out of 250 cases of accidental poisoning from the medicinal use of cocaine, 13 proved fatal.

Chronic poisoning, or cocamania, is not infrequently seen. The victim of the cocaine habit rapidly loses flesh and sometimes suffers from fainting fits. Among the phenomena characterizing the condition are disorders of the circulatory system, insomnia, mental failure, and delusions not unlike those of chronic alcoholism. Visual and other hallucinations, generally of a disagreeable type, are often present, and one symptom which is regarded as pathognomonic of subacute or chronic intoxication with this drug is a sensation of crawling worms or insects ("cocaine bugs") under or on the skin. Sometimes there is delirium or acute mania. The central nervous system seems to undergo degeneration like that observed in chronic morphine poisoning. Cocaine *habitués* are by no means infrequently met with. The moral degradation is fully equal to that of opium-eaters. Cocaine, which is usually taken by hypodermatic injection in these cases, is often employed in association with morphine, and the habit is sometimes acquired by those making use of this drug to break themselves of the morphine habit.

Treatment.—**Acute poisoning.** If the drug has been taken by the mouth the stomach should first be evacuated by washing out or by the use of apomorphine. The treatment is mainly one of stimulation, and strychnine is especially indicated as a respiratory stimulant. Artificial respiration may also be called for. Amyl nitrite may be of service if the blood-pressure is high, and small quantities of chloroform or ether, by inhalation, may be required for the convulsive attacks.

Chronic poisoning.—The habit is difficult to cure, as relapses are frequent. The most important point in the treatment is the withdrawal of the drug, though the sudden stopping of it may bring on profound collapse. There is little chance of a successful result unless the patient is confined for a considerable time in an asylum or sanitarium.

Alpha-Eucainæ Hydrochloridum.—Alpha-eucaine hydrochloride (unofficial). (Eucaine Hydrochloride. Eucaine.)

ACTION OF EUCAINE HYDROCHLORIDE.

The general action of eucaine, both in cold and warm-blooded animals, consists in a marked excitation of the entire central nervous system, followed by paralysis; in toxic doses going on to death. Small doses administered to mice and rabbits cause increased reflex excitability, and increased but weakened respiratory movements. Medium doses in rabbits cause repeated tonic and clonic convulsions. The animals lie senseless on their sides, with dyspnœa, opisthotonos, and finally paresis of the posterior limbs. These phenomena are still more marked when large toxic doses are administered; the convulsions return continuously, and affect all the muscles of the body. The animals finally die when the paralysis reaches the respiratory muscles. When the dose is not a fatal one, the convulsions gradually cease, the increased reflex excitability disappears, and the paresis of the hind limbs slowly improves. The effect on the central nervous system is therefore at first excitant, and later, under toxic doses, paralyzing. The paralysis is a central one, for if the sciatic nerve of a frog poisoned with eucaine is exposed, and its peripheral end irritated with the induced current, the limb reacts in a normal manner. As regards its action on the heart and the blood-vessels, the subcutaneous and intravenous injection of small and medium doses slows the heart on the average from twenty to thirty beats per minute, but without otherwise modifying the beats or increasing the blood-pressure. This effect on the pulse is caused by the excitation of the central vagus; for section of the vagi causes an immediate increase of the pulse to the normal and above it, together with an increase of the blood pressure. Death occurs from paralysis of the respiratory centres, for the heart continues to beat for some time after the respiratory paralysis. It is claimed that eucaine solutions possess moderate antibacterial powers.

THERAPEUTICS OF EUCAINE HYDROCHLORIDE.

Eucaine is used in from 1 to 5, or even 10, per cent. solutions for the same purposes as cocaine. The anæsthesia comes on somewhat more slowly, with solutions of the same strength, but is about equal in degree to that produced by cocaine, and lasts about the same time. It possesses the disadvantage of causing hyperæmia of mucous membranes, and in 2 per cent. solution may irritate the conjunctiva. A 1 per cent. solution, however, does not cause any disturbance. It is preferable to cocaine in that its aqueous solutions are permanent and can be sterilized by heat without decomposition. It does not cause mydriasis nor disturbance of accommodation, nor does it dry the corneal epithelium, and further it is relatively safer, so far as circulation and respiration are concerned, than cocaine.

Beta-Eucainæ Hydrochloridum.—Beta-eucaine hydrochloride (unofficial). (Beta-eucaine.)

ACTION OF BETA-EUCAINE HYDROCHLORIDE.

In order to avoid the burning sensations, pain and hyperæmia to which eucaine may give rise, a substance known as Beta-eucaine (hydrochloride), closely related chemically to eucaine, has been recommended. Its chemical properties and its physiological effects, with the above exceptions, are the same. It is safe, being three and three-quarters less toxic than cocaine, does not affect the heart, and is unirritating. It does not produce, when employed in the eye, mydriasis, corneal lesions, nor disturbances of accommodation. It can be sterilized by boiling without deterioration; its solutions are permanent and do not decompose when kept.

THERAPEUTICS OF BETA-EUCAINE HYDROCHLORIDE.

Its field is the same as that of cocaine, and it may be employed for the various operations upon the eye, nose, ears, genito-urinary tract, in minor surgery and dentistry, and for infiltration anæsthesia. For medullary anæsthesia, while the after-effects seem no greater than with cocaine, the analgesia is not so uniform nor lasting. Its ease and certainty of sterilization by boiling are in its favor, and some operators are strong advocates of it. It is employed in from ½ to 4 per cent. (saturated) aqueous solution, but of the latter not more than 2 c.c. (30 ♏) should be employed at one time, although for a prolonged operation five times this quantity may be employed.

Holocaina.—Holocaine (unofficial). (Holocaine hydrochloride. Para-diethoxyethenyl-diphenyl-amidine hydrochloride.)

ACTION OF HOLOCAINE.

It is a local anæsthetic, and paralyzes the sensory nerves of the cornea and mucous surfaces even more powerfully than cocaine. It does not produce any necrosis, and has no effect upon the blood-vessels. It should not be used hypodermatically, as it is said to be about five times as toxic as cocaine. Even small doses cause in both frogs and warm-blooded animals convulsions which appear to be of cerebral origin. It is a muscle poison, a 1 per cent. solution rapidly paralyzing voluntary and cardiac muscles in the frog, and it also exerts a curare-like influence on the motor nerves. It is powerfully antiseptic: a 1 per cent. solution has not only an inhibitory effect upon pus organisms, but destroys them when they are exposed to its action for a certain length of time.

THERAPEUTICS OF HOLOCAINE.

It is used as a local anæsthetic for the same purposes as cocaine; while it has some advantages over the latter, it is necessary that its application should be renewed in from ten to fifteen minutes. It is largely employed in ophthalmic practice, where its peculiar value lies in the rapidity of its action and the fact that it leaves the pupil, accommodation and intra-ocular tension quite unaffected. Its germicidal power is a further advantage, and it has a very beneficial effect on septic ulcers of the cornea. Holocaine is widely used also in affections of the nose, throat and ear and in operative procedures upon these parts, and no toxic effects appear to have been observed from its use as a local anæsthetic. A 1 per cent. solution is generally employed, and it should be prepared in porcelain (*not* in glass), as this salt is very sensitive to alkalies, and even the small amount of alkali dissolved out of the glass on boiling a solution of it in a test-tube is sufficient to decompose it.

Orthoformum.—Orthoform (unofficial). Methyl-para-amido-meta-oxybenzoate.) **Dose, 0.30 to 0.60 gm.; 5 to 15 gr.**

Action of Orthoform.

It has a similar action on the sensory nerve terminations to cocaine, but as its chemical composition is entirely different from the latter, this is the only point in which it resembles it in its effects. The anæsthetic quality of orthoform is apparently due to its being an aromatic derivative. The special feature of its anæsthetic influence is its long continuance. Anæsthesia is caused for many hours, or perhaps even for days, by a single application of the powder to abraded surfaces, and the reason for this is that the drug becomes dissolved only very slowly, and hence remains in contact with the part for a long time. Occasionally it has been known to produce a necrosis. It is found, however, that it is unable to penetrate mucous membrane like cocaine, and on this account it produces its anæsthetic effect only when it comes into actual contact with exposed nerve-ends. Therefore on sound skin or mucous membrane it has no influence, and is consequently unfit for ordinary use as a surgical anæsthetic. On account of its very slight solubility, and because it is also excreted very rapidly, it is practically non-toxic. Its insolubility renders its subcutaneous use difficult, but it is stated that if it is artificially brought into solution and then injected, it is no less dangerous than cocaine. Apparently on account of its insolubility, it has very little influence on the system, whether applied to abraded surfaces or taken by the mouth, even in very large amounts.

Therapeutics of Orthoform.

It is commonly applied as a dusting powder or in ointments. In burns, ulcers, abscesses, etc., where it can reach nerve terminations, it is very efficient in relieving pain, and also exerts a healing influence similar to that of iodoform; but in affections of the nose or throat it has very little effect unless ulceration be present. In ulcerative disease of the larynx if a spray consisting of a solution of 0.30 gm. (5 gr.) of orthoform in 3 c.c. (50 ♏) each of alcohol and water is made use of, a protective coating is deposited on the parts. Or, an emulsion of 1 part orthoform to 4 parts olive oil may be applied to the larynx. Insufflation of the powder is also frequently employed in diseased conditions of the throat and nose. For many purposes the saturated solution of orthoform in collodion is most effective. Orthoform has been used with much success in gynæcological and genito-urinary practice, as well as dentistry, and, administered by the mouth, it is very efficient in controlling the pain of ulcer or cancer of the stomach. It is of no service, however, in relieving headache or neuralgic conditions. It is sometimes employed hypodermatically to produce local anæsthesia for surgical operations, it being found that after violent shaking in water it is divided into such small particles that they can be injected with a somewhat large needle. The pain caused by the passage into the tissues may be obviated by a preliminary injection of a small quantity of cocaine. Orthoform when applied to ulcers has been known to produce sloughing similar to that caused by pure phenol, and on the skin to cause redness and irritation and even a decided pruritic eruption. In rare instances it is stated to have given rise to an erythema complicated with vesicles and to gangrenous eruptions.

ETHYL CHLORIDE.

ÆTHYLIS CHLORIDUM.—Ethyl chloride. (Mono-chlor-ethane. Hydrochloric ether.)

ACTION OF ETHYL CHLORIDE.

Ethyl chloride is an inflammable liquid which is even more volatile than ether, entering into ebullition at 12.5° C. (55° F.), and producing intense cold by its evaporation.

THERAPEUTICS OF ETHYL CHLORIDE.

External.—It is used for the production of local anæsthesia and to relieve the pain of neuralgia, etc. It is supplied in hermetically sealed glass tubes having a pointed extremity, and when the end is broken off and the tube held in the hand, it escapes in a fine stream which is directed upon the part it is desired to affect. The skin should first be cleansed of all fat by the use of soap, followed by washing with ether.

Internal.—More recently ethyl chloride has been used with considerable success as a general anæsthetic for short operations and as an anæsthetic preliminary to ether or chloroform in longer operations. It acts very promptly, and is preferably employed with a special inhaler. It is safer than chloroform, and while one authority has collected a series of twenty-two fatalities occurring under its use, in his own personal experience, embracing over two thousand cases, there have been no fatalities; though in two instances there was a temporary respiratory arrest, with considerable cyanosis and wide dilatation of the pupils. His conclusion is that ethyl chloride is to be regarded as a valuable addition to the anæsthetist's armamentorium for properly selected cases.

E. DRUGS ACTING ON THE SPINAL CORD.

1. Drugs increasing the irritability of the anteria cornua.

NUX VOMICA.

NUX VOMICA.—Nux Vomica. (Poison Nut. Dog Button.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Extractum Nucis Vomicæ.**—Extract of Nux Vomica. **Dose, 0.015 gm. = 15 milligm. (1/4 gr.).**

2. **Fluidextractum Nucis Vomicæ.**—Fluidextract of Nux Vomica. **Dose, 0.05 c.c. (1 ♏).**

3. **Tinctura Nucis Vomicæ.**—Tincture of Nux Vomica. **Dose, 0.6 c.c. (10 ♏).**

STRYCHNINA.—Strychnine. **Dose, 0.001 gm. = 1 milligm. (1/64 gr.).**

Preparations.

1. **Elixir Ferri, Quininæ et Strychninæ Phosphatum.**—Elixir of the Phosphates of Iron, Quinine and Strychnine. **Dose, 4 c.c. (1 fl. dr.).**

2. **Glyceritum Ferri, Quininæ et Strychninæ Phosphatum.**—Glycerite of the Phosphates of Iron, Quinine and Strychnine. **Dose, 1 c.c. (15 ♏).**

3. **Pilulæ Laxativæ Compositæ.**—Compound Laxative Pills. **Dose, 2 pills.**

4. **Syrupus Ferri, Quininæ et Strychninæ Phosphatum.**—Syrup of the Phosphates of Iron, Quinine and Strychnine. **Dose, 4 c.c. (1 fl. dr.).**

5. **Syrupus Hypophosphitum Compositus.**—Compound Syrup of Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

STRYCHNINÆ NITRAS.—Strychnine Nitrate. **Dose, 0.001 gm. = 1 milligm. ($\frac{1}{64}$ gr.).**

STRYCHNINÆ SULPHAS.—Strychnine Sulphate. **Dose, 0.001 gm. = 1 milligm. ($\frac{1}{64}$ gr.).**

ACTION OF NUX VOMICA AND STRYCHNINE.

External.—Strychnine is a very powerful **antiseptic,** and when injected subcutaneously in concentrated solution it is irritating of the tissues.

Internal. *Gastro-intestinal Tract.*—Nux vomica is a **stomachic bitter,** increasing the appetite, aiding the digestion, and acting generally like other agents of this class. In the intestine it is directly stimulating to the muscular coat of the bowel. Hence it **promotes peristalsis** and has a purgative action. Strychnine is believed to be absorbed mainly from the intestine.

Circulation.—Strychnine, by stimulating the vaso-motor centre, produces **constriction** of the **arterioles,** thereby causing a **rise of blood-pressure,** which is augmented by the increased peripheral resistance arising from the general activity of the muscles. The result is that the force of the heart is increased and the diastole lengthened. The pulse is also slowed by the stimulation of the vagus centre in the medulla. The direct action on the heart is probably less marked than has been generally supposed. In experiments upon the excised mammalian heart it has been found that a small dose slows the heart and increases its force, while somewhat larger doses cause a slight acceleration, also with increased force. It is thought likely, however, that these effects are not sufficiently marked to be of therapeutic importance. Very large doses cause cardiac muscular paralysis. During the convulsions caused by the alkaloid the blood-pressure is raised to an extreme height, partly by the action on the vaso-motor centre and partly, it may be, in consequence of the blood being pressed out of the abdominal organs and the muscles by their violent contraction. Immediately after a convulsion the blood-pressure falls. The vascular constriction, it would seem, affects chiefly the internal vessels, while, as a result probably of stimulation of vaso-dilator areas in the medulla, those of the skin and possibly of the muscles are dilated; consequently there is an afflux of blood to the extremities and cutaneous surface. The heart is found to beat long after the respiration has failed, and if artificial respiration be maintained, may continue to do so for an indefinite period. Blood that is mixed with strychnine and shaken with air contains more oxygen and less carbon dioxide than ordinary blood, but there is no reason to suppose that strychnine, at least in ordinary doses, increases the oxidizing power of living blood.

Respiration.—The **respiratory centre** in the medulla is **stimulated** directly and also reflexly by reason of the increased muscular activity. The respiratory movements are consequently **accelerated** and **strengthened.** As the muscles of respiration participate in the general convulsive seizures, however, they ultimately become completely exhausted, and death by asphyxia may occur suddenly after a spasm. In other instances the fatal result is due to gradual paralysis of the respiratory centre. Between the convulsions the breathing is usually fairly regular, but during their presence it is arrested by the violent contraction of the diaphragm and the other respiratory muscles.

Nervous System and Muscles.—The cerebrum is believed to be somewhat affected by strychnine, though to a less extent than the lower divisions of the central axis. In man the intellect and consciousness remain unaffected, but the **special senses** are rendered **more acute,** and the majority of investigators maintain that the irritability of the motor parts of the cortex is distinctly increased, except during a convulsion. In the medulla oblongata there is produced an active **stimulation, followed by paralysis,** of the respiratory, vaso-motor and vagus centres. While the stimulation of the vagus causes slowing of the pulse, this effect is more or less offset by the influence of the convulsions, since great muscular activity always tends to accelerate the heart. The clinical evidence is in favor of the cardiac centre's being strongly influenced. Strychnine in small amounts increases the tone of the medulla, augmenting the impulses which the medullary centres are constantly receiving. Consequently, the increased activity of the higher reflex areas may diminish or inhibit the irritability of the cord, so that the reflex response from the latter may be rendered more marked by the removal of the cerebrum and medulla oblongata. The most marked effect of toxic amounts of strychnine is an **increased reflex irritability** of the **spinal cord,** which is shown most conspicuously by the production of **tetanus.** After a short period of augmented reflex excitability, severe spasms occur, in which there are sudden and violent contractions of all the muscles of the body, the stronger extensor muscles generally prevailing against the flexors. In the intervals, lasting only a few minutes, between the convulsions there is complete relaxation. Mammals usually die after the first few spasms, but in frogs, in which respiration can be dispensed with for long periods, the alternations of convulsions and the quiescent state may continue for hours or days. That these **spasms** are of **spinal origin** is shown by the fact that they are at least as well marked, if not more violent, both in mammals and frogs, when the brain has been destroyed or severed below the medulla oblongata, while destruction of the spinal cord stops them entirely. Muscle and motor nerve endings may be excluded by section of the nerve-trunk, which stops the convulsions; while sensory nerve endings may be excluded by ligating a leg, with the exception of the nerve, and then injecting strychnine. The leg will be seen to take part in the convulsions, although its sensory terminations are excluded from the poison. The convulsions take place if the posterior nerve-roots are cut, provided the proximal end is stimulated and if a probe be slowly passed down the spinal canal of an animal convulsed by strychnine, the spasms of the muscles will successively cease from above downward. Furthermore, the convulsions are not only spinal, but reflex; so that they will not occur unless some stimulus from without reaches the cord. After the convulsive action has been established the spasms may seem to occur without any such stimulus, but this is not the case, for they may be induced by a very insignificant stimulation, as for instance, a slight contraction of a muscle. The **conduction power** of the **cord** is **enormously exaggerated** by strychnine, since general convulsions follow upon a peripheral stimulation so slight as to be even imperceptible. Strychnine convulsions are abolished by curare, for the latter has the effect of blocking impulses from the cord to the muscles. The exact location of the action of strychnine in the spinal cord has not as yet been determined. In the present state of our knowledge it may be said that the drug removes resistances which normally oppose the passage of impulses somewhere between the point at which the centripetal fibres enter the cord and the motor cells, but does not apparently act upon the motor cells of the anterior horn, nor upon those of the posterior root ganglion. It is consequently regarded as most probable that it affects chiefly some cells intercalated between these structures. Strychnine does not seem to have any direct action on the voluntary muscles. While very small quantities have the effect of increasing their tone, this is attributable to action on the spinal cord and not on the muscle fibres. Neither muscles nor afferent nerves are affected by the largest doses of the poison. Under large quantities the motor nerve endings are paralyzed by the direct action of the drug, but this effect is probably only to be observed in certain species of frogs, in which these terminations are paralyzed before the central nervous system. In mammals central paralysis destroys life before paralysis of the nerve endings is induced, though towards the end of a case of poisoning their functional activity is said to be depressed.

Special Senses.—Mention has been made of the influence of strychnine in increasing the acuteness of the special senses. This effect is produced by small doses, and is believed to be probably a cerebral action, although it is contended by some that it is due to alterations in the peripheral organs. While the acuteness of the hearing and the sense of smell is apparently increased, the effect of the drug is most decidedly shown in the sense of touch, the delicacy of which is markedly augmented, and in the vision. The field of the latter is enlarged, especially for blue, and differences can be recognized between shades of color which ordinarily seem identical; while in certain conditions of amblyopia light is said to be rendered much more distinct.

Metabolism.—In consequence of the violent contractions of the muscles throughout the body, there is naturally an increased oxidation, and the amount of oxygen absorbed and of carbon dioxide excreted by the lungs shows a corresponding augmentation. This increased excretion of carbon dioxide is found, however, to occur, though to a less extent, even when the skeletal muscles have been curarized, and it is concluded, therefore, that it is due in part to the contraction of the muscular coats of the blood-vessels and possibly to the increased metabolism of the central nervous system. There is an increased production of heat in consequence of the increased oxidation of the tissues, but this is offset, to a varying degree in different animals, by an augmented skin dissipation. While, however, the internal temperature may be even slightly lower than normal, the cutaneous temperature generally shows a considerable rise on account of the afflux of blood to the surface.

Elimination.—Strychnine, which is rapidly absorbed, is excreted in part unchanged, principally in the urine, but also in the saliva, sweat and bile. The excretion, although it commences promptly, is very prolonged, usually continuing for a week or more. Part of the strychnine is destroyed, probably through oxidation, in the tissues. The characteristic symptoms of the poison are found to be very much less marked when the animal is placed in an atmosphere of oxygen, and it is also stated that if the dose, large enough to prove fatal under ordinary circumstances, is injected into the leg of the animal, but prevented from reaching the circulation for an hour, it has absolutely no effect. Strychnine is said to be retained for a long time in the liver and central nervous system.

THERAPEUTICS OF NUX VOMICA AND STRYCHNINE.

External.—On account of its very pronounced toxic character, strychnine is never employed for antiseptic purposes.

Internal. *Gastro-intestinal Tract.*—Tincture of nux vomica is an admirable stomachic bitter, and is especially useful in cases where impairment of digestion is due to enfeeblement of the general system. 1.20 c.c. (20 ♏) of it in a wineglass of hot water will frequently at once check gastro-intestinal fermentation. Nux vomica may often be combined with good effect with diluted hydrochloric acid and some such bitter as gentian or cinchona. In the gastric catarrh and morning vomiting of drunkards it is considered as next in value to arsenic. It may be given advantageously with mineral acids. In cases of constipation in which the contractile power of the muscular coat of the intestine is feeble, in consequence, like the impaired digestion referred to, of general weakness of the system, it is of great service in promoting peristalsis by its action on the intestinal muscle. In instances of this kind it is commonly associated, in pill or otherwise, with remedies especially appropriate to the special condition of the patient, as, for instance, with preparations of iron in cases of anæmia. It has sometimes proved useful in epidemic dysentery, and in some epidemics of cholera, strychnine, combined with opium and mineral acids, has appeared to ward off the stage of collapse. Nux vomica has been advised in a variety of indefinite conditions of depression and general want of tone, in which it is difficult to say whether the results are to be ascribed to its effect in improving the appetite and digestion or in increasing the activity of the spinal cord and medulla.

Circulation.—Nux vomica and strychnine are useful as cardiac stimulants, especially in cases of disease of the heart in which digitalis is contra-indicated. They are sometimes combined with other cardiac stimulants, such as caffeine. In instances of urgent danger from failure of the heart's action in the course of chronic cardiac disease and other affections the prompt use of strychnine by hypodermatic injection not infrequently proves of the greatest service.

Respiration.—Strychnine is an excellent respiratory as well as cardiac stimulant. It may be given with expectorants when there is an abundant mucous secretion and little effort is made for its expulsion, but is contra-indicated in dry constant cough with small expectoration. It is especially valuable when in bronchitis and other thoracic diseases the respiration has become weak and shallow. In pneumonia it is extremely useful when death is imminent from dilatation of the right heart. In this condition it should be administered hypodermatically and at frequent intervals. In many cases of poisoning also, especially by agents tending to cause failure of the respiration, its employment in judicious doses by this method serves a useful purpose on account of its pronounced stimulating action upon the respiratory centre in the medulla. Strychnine has been recommended in the night-sweats of phthisis, on the supposition that these are due to imperfect respiration during sleep.

Nervous System.—In nervous diseases strychnine has been used to quite a large extent, and often without proper discrimination. Consequently, the results obtained have not always been of a satisfactory character. On account of its action on the central nervous system, it is prescribed in different forms of paralysis, and some restitution of function, or, it may be, some retardation of the disease, may attend its use in many of them. It is found that the cases in which it is of the most benefit are those in which there is present no appreciable or no well-marked central anatomical lesion, as in hysterical, neurasthenic, diphtheritic and syphilitic paralyses, and in paralysis due to such poisons as lead and arsenic. Little is to be expected from it when sclerosis exists, and in paralysis resulting from cerebral apoplexy it may possibly prove injurious in consequence of the congestion of the brain and tendency to recurrence of the hæmorrhage caused by its action in increasing the blood-pressure. It may, however, be sometimes given with advantage in hemiplegia when sufficient time has elapsed to permit repair of the damage done by the extravasation, and is of most service when the paralyzed members are completely relaxed. When the paralysis has existed so long that the muscles have undergone fatty degeneration it is quite useless. Strychnine is always contra-indicated in paralytic cases when headache, vertigo and tinnitus aurium are present. It sometimes proves useful in the nocturnal enuresis of children, as well as of incontinence of urine in adults, and this has been attributed to the increased tone of the sphincters resulting from augmented excitability of the spinal cord. Apparently on account of the action of the cord, it has also been used as an emmenagogue and as an aphrodisiac in impotence. Combined with the fluidextract of ergot, tincture of nux vomica has been recommended as a remedy for post-partum hæmorrhage, and the neuralgic form of dysmenorrhœa may sometimes be cured by nux vomica given between the menstrual periods.

TOXICOLOGY.

Symptoms.—The time of the appearance of the symptoms will depend largely upon individual differences and upon the manner of introduction. If the poison is taken by the mouth, the promptness of its action will be affected by the condition of the stomach, whether empty or full, and by the nature of the food, if any is present. If subcutaneous injection has been employed, the time will be affected somewhat by the place of introduction. Strychnine will act more rapidly than tincture of nux vomica, and both of these more quickly than pills. The symptoms do not often develop in less than fifteen minutes, and are not generally delayed beyond half an hour, but have been known not to appear for nearly two hours. If the dose is within therapeutic limits and yet sufficient to produce an ontoward effect, the first symptom is likely to be a feeling of uneasiness with a heightened reflex irritability, and this may be followed by muscular twitching in some part of the body. When a large dose has been taken, with or without a preliminary sense of impending suffocation convulsive movements begin, which have the effect mechanically of causing the patient to cry out or shriek, and they are very quickly followed by the characteristic spasms, which now set in with great violence. These are at first clonic and then tonic. Opisthotonos results from the extensor muscles overcoming the flexors, and the feet are curved inward. The spasms then again become clonic, and soon an intermission ensues. Suddenly the convulsions start up again, and there is thus an alternation of the convulsive attacks and remissions. During the latter there is complete muscular relaxation and general depression in the place of stimulation. With each successive attack the symptoms increase in violence. The patient often rests on his head and feet, the remainder of his body being arched above the bed or floor. The face becomes livid and the eyeballs staring, while the chest and abdomen are stiff as boards. The contractions of the facial muscles occasion *risus sardonicus,* the patient grinning in a ghastly manner, but those of the jaw are not affected till towards the last. This aids in distinguishing strychnine poisoning from tetanus, in which the muscles of the jaw are implicated very early. Other diagnostic marks of tetanus, as contrasted with it, are the slower development of the symptoms and the continuous muscular rigidity; for while between the paroxysmal exacerbations there is some diminution of this, there is never complete relaxation, as in strychnine poisoning. During the attack (in strychnine poisoning) the pulse is very rapid, and the sight, hearing and sense of touch become abnormally acute. The patient is entirely conscious, and usually suffers excruciating pain, though in exceptional instances the asphyxia produces more or less anæsthetic effect. The interference with circulation and the pressure on the abdominal viscera, aided by the stimulation of the medullary centres, may give rise to vomiting and purging. The respiration during the attack is at first labored and dyspnœic, and then is temporarily arrested by the spasmodic contraction of the diaphragm. Foaming at the mouth may occur in consequence of the interference with respiration, and the asphyxia resulting from the latter induces cyanosis, dilatation of the pupils, and eventually coma. In the intermission the patient lies exhausted, and covered with a cold sweat. The slightest noise or touch, or even a bright light, is likely to bring on a convulsive seizure, which may jerk the patient out of bed. The number of seizures varies in different instances, but three or four are usually fatal; the patient succumbing to asphyxia and exhaustion. The smallest dose of strychnine known to have proved lethal is .03 gm. (½ gr.). *Post-mortem.* As in other conditions characterized by violent convulsions, there is early and often persistent rigor mortis. The appearances are those due to asphyxia and the convulsions: venous engorgement of the internal organs and, generally, hyperæmia of the central nervous system, with small hæmorrhages. Quite rarely there is also hyperæmia of the mucous membrane of the gastro-intestinal tract.

Treatment.—Give emetics (p. 159), particularly apomorphine hydrochloride hypodermatically, or wash out the stomach if the patient is seen early enough for the passing of the tube not to cause spasm. Lavage may be practised with solution of potassium permanganate, as in cases of opium poisoning, but it is not so effective here. If very violent convulsions are already present, evacuation of the stomach, as a rule, should be avoided, as either emetics or the stomach-pump will have the effect of starting the spasms. Both potassium permanganate and iodine are chemical antidotes, and when one of these is employed, it is not so necessary to empty the stomach. When a fatal dose has been taken, however, the chances are that neither evacuation or any chemical antidote will be of service, for by the time the physician can arrive sufficient of the poison will probably have been absorbed to render both useless. Chloroform is the best physiological and most practical antidote, and it has the special advantage that its action can be very largely controlled. Hydrated chloral may be useful, and is often advised, but is open to the objection that with it there is always the risk that its paralytic effects may coincide with those of the strychnine, and thus increase the patient's danger. Both chloral and morphine are antidotal to strychnine as regards the effect on the cerebrum, but this is of little importance, because morphine may only add to the gravity of the symptoms by increasing the reflex excitability of the spinal cord and by its depressing effect on the respiration. Although calabar bean and gelsemium are theoretically more perfect physiological antagonists, since both depress the anterior cornua, they are practically of very little value in strychnine poisoning. Other measures which have been recommended are the administration of large doses of potassium bromide *per rectum* and the use of amyl nitrite inhalations. If the patient is seen early, the employment of tannin in large quantities may be of service, as the insoluble tannate is formed in the stomach. This should be gotten rid of, however, as soon as possible, as it becomes broken up by the action of the gastric juice, and the strychnine is then rapidly absorbed. It is claimed as a result of animal experiments that the application of external heat decreases the mortality. Artificial respiration, as well as the inhalation of oxygen, should usually be begun early.

2. Drugs which depress the activity of the anterior cornua.

CALABAR BEAN.

PHYSOSTIGMA.—Physostigma. (Calabar Bean.) **Dose, 0.100 gm. = 100 milligm. ($1\frac{1}{2}$ gr.).**

Preparations.

1. **Extractum Physostigmatis.**—Extract of Physostigma. **Dose, 0.008 gm. = 8 milligm. ($\frac{1}{8}$ gr.).**
2. **Tinctura Physostigmatis.** — Tincture of Physostigma. **Dose, 1 c.c. (15 ♏).**

PHYSOSTIGMINÆ SALICYLAS. — Physostigmine Salicylate. (Eserine Salicylate.) **Dose, 0.001 gm. = 1 milligm. ($\frac{1}{64}$ gr.).**

PHYSOSTIGMINÆ SULPHAS.—Physostigmine Sulphate. (Eserine Sulphate.) **Dose, 0.001 gm. = 1 milligm. ($\frac{1}{64}$ gr.).**

ACTION OF CALABAR BEAN.

External.—A strong solution of physostigmine is said to have the effect of slightly diminishing the functional activity of motor and sensory nerves, while, applied to the conjunctiva, it causes contraction of the pupil, myopia, and dimness of vision.

Internal. *Alimentary Tract.*—Physostigmine has the effect of **increasing** the **secretions** of the glands, especially the salivary, mucous, lachrymal, sweat, and pancreatic, and this is due to its stimulating action on the terminations of the secretory nerves in the gland-cells. It thus acts on the same point as atropine, but in an exactly opposite manner. After the drug has been absorbed, therefore, there is usually an augmented flow of saliva, but the secretion may be inhibited or soon checked by the contraction of the arterioles caused, and the consequent insufficient nutrition of the gland cells. In the stomach and intestine it induces a marked **increase in peristalsis,** in consequence, it is believed, of its action on the nerve endings in the muscular coats of these viscera, and consequently, if the dose is not too small, vomiting and purging are caused. The powerful contractions to which it gives rise are of the same general character as those produced by pilocarpine, but it is found to differ from them in causing these movements after small quantities of atropine, while larger doses of atropine again stop the contractions set up by physostigmine. The peristaltic movements culminate in a **tetanic contraction** of the muscular walls, which prevents the passage onward of the contents of the viscera.

Unstriped Muscle.—On unstriped muscle in many parts of the body physostigmine has the same action as in the gastro-intestinal tract. It thus probably induces contraction not only of the iris, but of the bronchial tubes, spleen, uterus, ureters, and the gall and urinary bladders. It is also said by some to affect the arterioles in the same way, but proof is lacking that it causes contraction of their muscular coats by stimulating the vaso-motor terminations in them.

Circulation.—In consequence of the violent contractions of the stomach and intestine, which expel the blood from a very large area, and also in part, it is supposed, of a stimulation of the vaso-motor centre in the medulla, there is a considerable **rise** in the **blood-pressure.** The contraction of the cardiac muscle is strengthened in frogs. This is denied as regards mammals, but some reliable investigators claim to have demonstrated it in experiments on dogs. However this may be, the pulse is **slowed** by physostigmine, and this is believed to be due to its direct action on the heart muscle rather than to any inhibitory interference, since slowing occurs even after large amounts of atropine. The amplitude of the cardiac movements, whether due to a strengthening of the contractions or to the slow rhythm, is afterwards diminished, and in the frog large doses cause arrest of the heart in systole. The rise in blood-pressure is also succeeded by a fall, and this is ascribed to paralysis of the vaso-motor centre. If large quantities of the alkaloid are injected, there is an immediate fall in the blood-pressure, and this is accompanied by a further slowing of the pulse. In the frog, physostigmine, by reason of its effect in increasing the irritability of the cardiac muscle, is capable of starting a heart which has been stopped by muscarine.

Respiration.—The respiration, which is at first quickened and strengthened, soon becomes retarded and dyspnœic, and death, which is due to paralysis of the respiratory centre, takes place from **asphyxia.** The primary acceleration may be due in part to stimulation of the sensory terminations in the lungs and partly to central stimulation. The subsequent dyspnœa is no doubt owing in some measure to spasm of the bronchial muscles, as well as to depression of the respiratory centre in the medulla.

Nervous System.—It is not known positively whether or not any general stimulation of the central nervous system is caused by physostigmine, but the primary quickening of the respiration, as well as the changes in the blood-pressure, points strongly towards this. As regards the cortex, it is still undetermined whether the collapse met with in severe poisoning is preceded by a stage of slight stimulation. There is no question as to the drug's causing **central depression.** Whether this begins in the spinal cord and medulla, and only spreads to the cerebrum after large doses, is unknown, and some observers hold that the higher centres are depressed earlier than the lower ones. In man, however, at least, the consciousness remains unimpaired after the respiration and muscular power have become seriously affected; indicating that some of the higher cerebral areas preserve their functions after others have been weakened. In the medulla, as has been mentioned, the respiratory and vaso-motor centres eventually become paralyzed. **Reflex activity** is **inhibited** in consequence of **depression** of the **anterior cornua** of the spinal cord, as may be seen when physostigmine is applied directly to the cord. At first such activity is slightly increased, but this is the result of irritation, such as may be caused by almost any substance, and there soon succeeds a total abolition of reflex excitability. Subsequently there is paralysis of the posterior portion of the cord also, with diminution of cutaneous sensibility.

Muscles and Nerves.—In mammals **muscular twitchings** are caused by large amounts of physostigmine, and constitute one of the most characteristic features of the poisoning. They are also observed in frogs, but much more rarely. In some instances they are so pronounced in warm-blooded animals as to simulate convulsions, but are distinguished from the latter in not involving the whole of a muscle at one time. This phenomenon is probably attributable to the action on the motor nerve terminations, though some hold that it is due to direct action on the muscle.

Eye.—Although the application of a solution of physostigmine to the conjunctiva always causes the **pupil** to **contract** to its smallest diameter, this effect is not invariably observed in systemic poisoning. In man, however, some contraction is generally produced. Such a variation points to its being due to changes in the local mechanism, and there is every reason to suppose that it is caused by a stimulation of the ends of the motor fibres in the sphincter, such as is seen in unstriped muscle elsewhere. By its effect on the motor nerve terminations in the ciliary muscle it causes **spasm** of **accommodation**, in addition to the contraction of the pupil from its influence on the iris, and in consequence of the myosis there results a **diminution of intra-ocular pressure.** Associated with these phenomena, especially when they are decidedly pronounced, there are apt to occur some twitching of the lids, dimness of vision, and supra-orbital pain.

Excretion.—Physostigmine is readily absorbed and is eliminated chiefly in the urine, though traces of it have been found in the bile and saliva. The action of the alkaloid is much more constant than that of calabar bean itself, and this may be because the effects of the other active principles in the crude drug interfere to some extent with those of the physostigmine.

THERAPEUTICS OF CALABAR BEAN.

Unstriped Muscle.—Calabar bean has been used to a limited extent in affections in which its property of stimulating involuntary muscle may be availed of. It has a certain value in atony of the bladder and intestines and in catarrh of the bowels, and is sometimes given in purgative pills to stimulate the muscular layer of the intestine. Combined with nux vomica, it has been employed with advantage in gastric and intestinal dilatation. It has been especially recommended for the troublesome flatulence of women at the time of the menopause, which is ordinarily associated with a paretic state of the muscular coat of the bowel, and it is stated that with the relief afforded to the flatulence there usually comes relief to the headache, vertigo and morbid fancies so often attending it. In chronic bronchitis with deficient power of expectoration, bronchial asthma, and emphysema it may be of service in promoting the expulsion of mucus by its influence over the muscular fibres in the bronchial tubes.

Central Nervous System.—Calabar bean has been quite largely employed in the treatment of tetanus, but as a considerable number of cases of this disease show a tendency to spontaneous recovery, it is difficult to determine its real value. About one-half the cases in which it has been used are said to have been reported cured, and it is possible that this proportion might have been larger if sufficient attention had been paid to the quality of the drug employed and to the mode of administration. It has been advised by competent authority always to commence the treatment by a subcutaneous injection and to repeat such injection until the system is decidedly affected; then to administer the remedy by the mouth in doses three times as large as those employed hypodermatically. Instead of the bean, it is better to employ physostigmine sulphate. Doses of .002 gm. ($\frac{1}{32}$ gr.) may be given hypodermatically and frequently repeated, the condition of the patient in the meanwhile being watched with great care. This remedy has been resorted to in trismus neonatorum and other spasms, but with only moderately good results. It has also been extensively tried in epilepsy and chorea, but in most cases has proved of little service and in others has seemed positively deleterious. Physostigmine has been given as an antidote for strychnine poisoning.

Eye.—A solution of physostigmine salicylate (1 or 2, to water, 480) is dropped in the eye to break up adhesions of the iris, to diminish intra-ocular tension, and to prevent prolapse of the iris after wounds, or ulcers of the cornea. It is also employed in glaucoma, in paralysis of the iris and ciliary muscles, and to prevent the entrance of light into the eye in photophobia. It is useful when for any reason it is desired to rapidly overcome atropine mydriasis, but as it is less powerful than atropine, a larger amount will be required for this purpose than it took of atropine to produce the contraction of the pupil.

ANTAGONISM.

It will be observed that in its action on the pupil and on involuntary muscle generally, on secretion, on the heart, and on respiration, physostigmine is antagonistic to atropine. In its action on the spinal cord and respiratory centre it is antagonistic to strychnine.

GELSEMIUM.

GELSEMIUM.—Gelsemium. (Yellow Jasmine.) **Dose, 0.065 = 65 milligm. (1 gr.).**

Preparations.

Fluidextractum Gelsemii.—Fluidextract of Gelsemium. **Dose, 0.05 c.c. (1 ♏).**

Tinctura Gelsemii.—Tincture of Gelsemium. **Dose, 0.5 c.c. (8 ♏).**

ACTION OF GELSEMIUM.

External.—If a solution of gelsemium or either of its alkaloids is dropped into the eye, it causes momentary smarting and hyperæmia of the conjunctiva together with rapid dilatation of the pupil and paralysis of accommodation.

Internal.—The action of gelsemium is essentially the same as that of gelseminine, which is much the more powerful of its two alkaloids. It usually has no effect on the alimentary tract, though in poisoning by it attempts at vomiting are observed in some animals.

Circulation.—Almost the only appreciable effect it has upon the circulation is to induce paralysis of the inhibitory mechanism of the heart. Very little change is observed in the blood-pressure in animals, even after large amounts, if artificial respiration is maintained after the failure of the natural respiration.

Respiration.—Gelsemium powerfully **depresses** the **respiration,** and when taken in toxic doses causes death by asphyxia. The failure of the respiration is probably due to paralysis of the respiratory centre, though it seems likely that partial paralysis of the nerve endings in the respiratory muscles may be a contributory cause. Before death the temperature falls, and the skin is covered with a cold sweat.

Nervous System and Muscles.—The action of gelseminine in general resembles in some respects that of coniine, but it differs from the latter in not causing any increase in arterial tension and in having a more depressant action on the central nervous system. The respiratory centre in the medulla oblongata, as has been mentioned, is apparently paralyzed. The higher cerebral functions and the sense of pain remain unimpaired until just before death. Gelseminine in poisonous amounts causes loss of coördinating power and extreme **muscular weakness,** with **marked tremor** when any movement is attempted. The animal falls to the ground and is presently unable to raise even its head, while the tremors, which are ascribed to the action on the nerve terminations, as in the respiratory muscles, become still more pronounced. The muscles, while not being completely paralyzed, are incapable of a continued contraction, in consequence of the failure of the nerve endings to transmit enough impulses for the purpose, and the interruptions of the contractions no doubt furnish the explanation of the tremor. Reflex excitability for the most part remains unaltered. In the frog the injection of gelseminine produces feebleness and slowness of movement, followed by a partial paralysis of the motor nerve endings in striated muscle. If the dose is sufficiently large, the animal is found to lie perfectly motionless and unresponsive to any form of stimulation, just as if poisoned by curare. It is stated that the contractions of the heart are unaffected by stimulation of the vagus, apparently because the ganglionic connections along the course of the inhibitory fibres are paralyzed by gelseminine, while, on the other hand, the terminations of the inhibitory fibres in the cardiac muscle seem to retain their function.

Eye.—The effects of the local application of gelsemium have already been referred to. The mydriasis is less complete and less persistent than that occasioned by atropine, but is thought to be due to the same cause, paralysis of the terminations of the motor oculi nerve. In general poisoning by it marked dilatation of the pupil does not occur until quite late. Disturbance of vision, followed by **diplopia** and **ptosis** is not infrequently observed after gelsemium, and these effects have been attributed to **paralysis** of the **ocular muscles.**

Therapeutics of Gelsemium.

At one time gelsemium was employed as a circulatory depressant, but is not now used in this way, since its other effects are so harmful. Nor is it any longer prescribed for convulsive diseases, as tetanus, whooping-cough, chorea, etc., as it was found not to do any good. It is often successfully used for migraine, though how it acts is quite uncertain. Gelsemium seems to be especially efficacious in neuralgia of the facial branches of the trigeminus. It is occasionally used locally to dilate the pupil and paralyze accommodation, and it has the advantage that its influence passes off rapidly. Gelsemium has been employed with success in the treatment of some cases of eczema and pruritus. It is advised that .60 c.c. (10 ♏) of the tincture should be taken every two or three hours until some of the characteristic effects of the drug appear. The tincture has also been used in Ménière's disease and to arrest attacks of bilious colic, in doses of 0.30 c.c. (5 ♏) every quarter of an hour. Gelsemium has sometimes proved of service in torticollis, rigid os in labor, after-pains, spasmodic dysmenorrhœa, hæmoptysis, laryngismus stridulus, asthma and whooping-cough, and as an antispasmodic in coughs in general.

BROMINE.

BROMUM.—Bromine.

Preparations.

1. **Ammonii Bromidum.**—Ammonium Bromide. **Dose, 1 gm. (15 gr.).**

2. **Calcii Bromidum.**—Calcium Bromide. **Dose, 1 gm. (15 gr.).**

3. **Lithii Bromidum.**—Lithium Bromide. **Dose, 1 gm. (15 gr.).**

4. **Potassii Bromidum.**—Potassium Bromide. **Dose, 1 gm. (15 gr.).**

5. **Sodii Bromidum.**—Sodium Bromide. **Dose, 1 gm. (15 gr.).**

6. **Strontii Bromidum.**—Strontium Bromide. **Dose, 1 gm. (15 gr.).**

7. **Zinci Bromidum.**—Zinc Bromide. **Dose, 0.125 gm. = 125 milligm. (2 gr.).**

ACTION OF BROMINE.

Bromine closely resembles chlorine in its effects on the system.

THERAPEUTICS OF BROMINE.

It is at present very little used in medicine. Locally it has been employed with success as a caustic in hospital gangrene, chancre and carcinoma uteri, but its escharotic action is attended with great pain. The vapor of bromine with alcohol (1 to 64) is sometimes used for inhalation in coryza and hay-asthma.

ACTION OF THE BROMIDES.

External.—Potassium, sodium and other bromides, locally applied in solution, are slightly sedative to mucous membranes, lessening the reflex excitability, especially of the pharynx.

Internal. *Alimentary Canal.*—Administered in bulk or concentrated solution, they induce salivation and thirst, and if the amount is large, gastric irritation with nausea and vomiting. Occasionally diarrhœa is caused by concentrated solutions reaching the intestine. These irritating effects are probably due for the most part to the withdrawal of fluid from the mucous membranes, as in the case of sodium chloride, and are not observed when the bromides are given in dilute solution. It has also been pointed out that bromides may disorder the stomach by so decreasing reflex action that the proper secretion of gastric juice and the digestive process do not take place with sufficient rapidity, and that for similar reasons they may cause constipation.

Nervous System.—They have a direct effect upon the central nervous system, that of the potassium salt being most marked because with it the bromide action is supplemented by the depressant action of the base. The action consists in a **depression** rather than an abolition of function. In man the bromides induce a diminution of mental activity in general, but this is affected in some respects more than others. Thus, the perception is but little impaired, while the appreciation apparently becomes decidedly defective, so that while stimuli reach the brain much as usual, they do not seem to be adequately apprehended. External objects are perceived, but arouse no interest in the patient, and frequently this state of apathy passes into **drowsiness** and **sleep.** The sleep, however, is never very deep and is not refreshing, while for several hours after waking the patient is apt to be more or less affected with mental confusion. Before slumber comes on there are observed fatigue, lassitude, disinclination for exertion, and often muscular weakness. There is also a marked **diminution in reflex activity.** Thus, the irritation of the mucous membranes of the genito-urinary tract is less liable to set up reflex movements, tickling of the fauces does not induce nausea, and after very large doses the conjunctiva may sometimes be touched without causing winking. In some instances the general cutaneous sensibility is also diminished, and after large doses there may be more or less complete anæsthesia, which extends to the skin. In addition to the ordinary reflexes, some special functions, as the respiration and the sexual instinct, are depressed. The depression of the spinal reflexes caused by the bromides renders them antagonistic to strychnine, so that in bromidized animals this alkaloid induces convulsions only when given in much larger amount than is ordinarily required for this purpose. As regards the motor areas of the cerebral cortex, it is found that a stimulation of the areas which, under the conditions of the experiment ordinarily give rise to general epileptiform convulsions, will, after the administration of bromide, be confined to the area directly stimulated. It would appear, therefore, that the whole cerebrum, as well as the spinal cord, is powerfully depressed by the bromides. In man, at least, the depression, beginning with the higher functions of the brain, takes place in regular order from above downwards, in the reverse order of the physiological development of the functions; the action, as in the case of many other drugs, following out the Law of Dissolution (*see* p. 639).

Circulation.—Large doses of potassium bromide have a depressant action on the heart, an effect which is due to the potassium ion. If the amount is sufficiently great, diastolic arrest may be caused in animals. Sodium bromide has little or no depressing influence, while the ammonium salt is slightly stimulating to the heart. After administration of the bromides there is often found a contraction of the blood-vessels of the pia mater, and this condition has been supposed to produce cardiac depression, but it seems probable that this anæmia of the brain is analogous to that observed in sleep, and is a result, rather than the cause, of the depression.

Respiration.—The respiration is more or less depressed by large doses. Under toxic amounts the breathing grows progressively slower and shallower, probably from depression of the respiratory centre. Asphyxia is the usual cause of death in animals, although if the potassium salt is employed in any large amount, fatal cardiac paralysis may be induced by the poisonous action of the potassium on the heart muscle. After a small toxic dose the frog's heart has been observed to continue beating long after the failure of the respiration.

Temperature.—In animals toxic doses not infrequently produce some fall of temperature, and this is regarded as being due to the lessened movement.

Sexual Organs.—Bromides have a distinct **anaphrodisiac** influence. Whether the depression of the sexual instinct which has been mentioned is due to the action on the cerebral cortex or on the spinal cord has not been determined. A failure of sexual vigor almost invariably results from the long-continued administration of the bromides.

Metabolism.—Under large doses there is a marked diminution in the amount of carbon dioxide exhaled. The quantity of urine is increased, particularly after the use of the lithium salt. The nitrogenous metabolism is not apparently affected, but the sulphur in the urine is increased, while quite commonly the phosphates are materially reduced.

Excretion.—The bromides, which are rapidly absorbed by the mucous membranes, are eliminated mainly by the kidneys, but to a small extent also in the perspiration and milk. There is probably some excretion likewise by the bronchial and intestinal mucous membrane. The disagreeable odor sometimes noticed in the breath in chronic poisoning has been supposed to be due to the elimination by the lungs of bromine or some of its volatile organic compounds. The hydrobromic acid secreted into the stomach in bromism is thought to be all reäbsorbed in the intestines. Some of the bromide is rapidly eliminated, as it can be detected in the urine a few minutes after injection, but the great mass of the drug is found to be excreted only very slowly. Therefore, under its continued administration there is an accumulation in the system, though it has been shown that the proportion excreted increases with the increase of the salt in the blood until an equilibrium is established, exactly as much bromine appearing in the urine as is absorbed from the stomach. After the discontinuation of the drug the excretion still goes on, and it has been detected in the urine for as long as sixty-five days later. The slow excretion of bromides is regarded as affording support to the theory that the bromine enters into combinations in the body, and it is thought probable that it may to some extent take the place of chlorine in the combinations of the latter, especially as the excretion of chloride is increased. The administration of sodium chloride, it is said, accelerates the excretion of the bromine, and ameliorates the symptoms of bromism.

Comparative Action of the Bromides.—Certain of the differences between the various salts have already been incidentally referred to, but a little further attention may be given to the subject. None of the bromides has any action on nerve and muscle unless applied directly to the excised structures. Potassium bromide is more depressant to the heart and to the central nervous system than the sodium salt on account of the influence of the potassium ion. Under large doses of ammonium bromide the convulsive action characteristic of ammonium has been observed in animals. The depressant action of lithium bromide is probably next to that of the potassium salt, and it is said by some even to exceed the latter in this respect. It is the richest in bromine, containing 92 per cent., and though it has not been so largely used as the others, is thought to have the most pronounced hypnotic influence of any. It is asserted that the strontium and calcium salts cause less disturbance of the digestion than the others, but they are apt to be absorbed more slowly by the intestine than those of the alkalies. Zinc bromide, if the dose is sufficiently large, may act as an irritant poison.

Therapeutics of the Bromides.

External.—Before the days of local anæsthetics it was customary to paint the pharynx with a bromide solution in order to diminish the sensibility of the throat before making a laryngeal examination. Finely powdered potassium bromide, with 5 parts of glycerin, has been used as a soothing application for painful hæmorrhoids and fissures of the anus, and in solution (1 to 24 of water) for the relief of paræsthesia.

Internal.—As would be inferred from their physiological action, the bromides are of great service in various nervous diseases for the relief of which a depressant effect is required. They are the most valuable remedies at our command in the treatment of epilepsy, their good effects being probably due to their influence in reducing the excitability of the cortical motor areas. When pushed in a suitable manner, they sometimes prove curative, and though this happy result is by no means always to be looked for, they are in most instances of great service in diminishing both the frequency and severity of the attacks. Consequently, they may be said to be indicated in every case of the disease, and their use should be abandoned only after a thorough trial has demonstrated their inefficiency. As a rule, they are more successful in cases of *grand mal* than of *petit mal*, and in cases in which the seizures occur in the daytime rather than in those where they are exclusively nocturnal. Potassium bromide is the one in most general use, and it seems to be considered as on the whole the most efficient. There are special circumstances, however, in which some one of the various other bromides possesses certain advantages and may succeed when the potassium salt has failed. Sometimes the combination of the three bromides, potassium, sodium and ammonium, acts better than any one of the salts alone. Belladonna often increases the efficiency of bromides in *petit mal.* As the bromides when applicable in epilepsy must be administered for an indefinite period, every effort should be made to minimize their objectionable effects upon the system. Thus, it is often advisable to intermit the remedy from time to time, or to change from one bromide to another. To counteract the depression, the bromide is sometimes given in infusion of calumba or digitalis, or strychnine is given hypodermatically at the same time. It has been claimed by some that most of the ill effects of the bromides may be avoided by giving them in combination with intestinal antiseptics, such as sodium salicylate and betanaphthol; while others have observed that taking strong coffee with the meals hinders the development of bromism. For the prevention or amelioration of acne, arsenic is the best remedy. When the convulsive attacks have ceased to make their appearance, it is advised that a single dose of 4 gm. (1 dr.) of bromide should be taken daily at bedtime for a year, and after that on alternate nights for at least a year longer. It is better that the remedy should not be discontinued altogether for fully three years. As hypnotics and for quieting nervousness and hysteria the bromides are often extremely useful, but their too long continued employment should be avoided on account of the risk of the patient's becoming an habitué of the drug. They are especially useful in the wakefulness of fatigue, worry and cerebral over-work. In various forms of convulsions both in adults and children they are efficient, particularly when combined with hydrated chloral. This combination may be useful also in delirium tremens. Here the dose of bromide should be very large, often as much as 4 gm. (1 dr.), and it is of more service in the preliminary stage of wakefulness and excitement than after the delirium is fully developed. Other affections in which bromides may be employed are laryngismus stridulus, the night-screaming of children, migraine, neuralgia, dysmenorrhœa and menorrhagia, particularly in young subjects, seminal emissions, satyriasis and nymphomania. In migraine and neuralgia the combination with caffeine is often very efficient. The bromides have been considerably used in the treatment of whooping-cough, but cannot be said to have proved of much value. They are of service in the laryngeal crises of locomotor ataxia and, in full doses, in acute laryngitis. In cases where irritability of the pharynx and larynx interfere with a satisfactory examination of these parts, the trouble may be obviated by the administration of one or two full doses, instead of the local application formerly practised. They are the best prophylactics as yet discovered for seasickness, and should usually be employed in doses of about .60 gm. (10 gr.) three times a day for a number of days before sailing, though a larger amount will sometimes be required. After seasickness has commenced, they should be given in small doses, frequently repeated, in an effervescing draught made by mixing a solution of citric acid with one containing the bromide and potassium bicarbonate. They may also be used in the same way in the vomiting of pregnancy, that following etherization, and other persistent forms of vomiting which are not due to primary gastric disturbance. In cases where this method proves inefficient, the bromide may be given, with the tincture of deodorized opium, in a small enema of starch water. The bromides have also been employed to prevent the nausea and depression resulting from opium, as well as for the symptoms of cinchonism and salicylism. They are of service in the abdominal neuroses, such as cholera infantum when it is due, not to defective alimentation or other local trouble in the gastro-intestinal tract, but to an irritable state of the nervous system. In some varieties of functional disease of the heart they are of decided benefit. Lithium bromide has been prescribed in various gouty and rheumatic conditions, and potassium bromide is recommended as an eliminating agent, combined with potassium iodide, in mercurial, copper and lead poisoning. In a considerable number of cases potassium bromide has proved successful in the treatment of tetanus. Not less than 15 gm. (½ oz.) should be given in the day, and hydrated chloral should be used as an hypnotic at night. This bromide, in full doses, is also of value as an antidote for strychnine poisoning.

Bromism.—The name bromism has been given to chronic poisoning by the bromides. It is to be noted that hydrobromic acid (*see* p. 691), although containing a larger proportion of bromine, rarely gives rise to this condition. Usually the first symptom is an eruption of papular acne, which appears chiefly upon the face and back. In severe cases the papules pustulate and then the pustules may coalesce, forming small abscesses and eventually ulcers. In other instances the rash produced resembles eczema, and in still others there is erythema or a brown discoloration of the skin. A coated tongue and disordered digestion are constant symptoms. There is not infrequently some coryza, with or without an increased secretion from the bronchial mucous membrane, and sometimes a mild conjunctivitis. These various effects are regarded as due to a local irritant action, due in part to the salt action of the bromide salt and in part to the decomposition of the bromide, with liberation of bromic acid and bromine, by the free acids in different situations: as hydrochloric acid in the stomach, carbon dioxide in the air passages, and the acid secretions of the sebaceous glands in the skin. This action is said to be favored by insufficiency of the kidney and to be more readily induced in old age. From the influence of the drug on the nervous system, the general cutaneous sensibility and the sensitiveness of the faucial mucous membrane are distinctly reduced, while the sexual appetite also becomes markedly diminished. The patient is indisposed to make any exertion and is easily fatigued, while his gait is uncertain and every movement may be attended by tremor. The mental phenomena observed are of the nature of continuations and exaggerations of the effects of a single dose. The intellect is dulled and the memory especially is affected. The patient takes little or no notice of what is going on around him, he speaks slowly and stammers, and is apt to mispronounce ordinary words or miss several words out of a sentence. The mental condition induces a stupid and apathetic expression of countenance, while the eyes become heavy and lustreless. Occasionally maniacal excitement, mental confusion, and even delirium are observed after continued use of moderate doses, particularly of the potassium salt. Those who take bromides habitually generally find themselves unable to sleep without them, and as a gradual increase of the dose is required to produce sleep, the effects on the system are usually disastrous. In addition to suffering from the special evils of bromism, the patient, on account of his lowered resistance, is rendered more liable to contract disease of any kind, and not infrequently the immediate cause of death is an attack of pneumonia or bronchitis. Notwithstanding the gravity of the symptoms in bromism, after the withdrawal of the drug they generally disappear soon after there no longer remains any bromine in the system.

ACIDUM HYDROBROMICUM DILUTUM.—Diluted Hydrobromic Acid. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF HYDROBROMIC ACID.

Hydrobromic acid appears to have the characteristic bromide action after absorption, but it also has the local action of an acid; which makes it more irritant than the bromides. While pleasanter to take than the latter, it is, therefore, more apt to create gastric disturbance.

THERAPEUTICS OF HYDROBROMIC ACID.

It was introduced as a substitute for the bromides, but it failed to fulfill the expectations of its usefulness, and is now very rarely employed for the same purposes. It has some repute in preventing the untoward symptoms of quinine, of which drug it is an excellent solvent. Thus, it is said to give prompt relief in the annoying tinnitus aurium occasioned by it, though it often fails in relieving tinnitus from other causes. It has been highly recommended for headaches due to eye-strain, especially in nervous women.

F. DRUGS ACTING ON THE BRAIN.

1. General cerebral stimulants.

BELLADONNA.

BELLADONNÆ FOLIA.—Belladonna Leaves. (Deadly Nightshade.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Emplastrum Belladonnæ.**—Belladonna Plaster.
2. **Extractum Belladonnæ Foliorum.**—Extract of Belladonna Leaves. **Dose, 0.010 gm. = 10 milligm. ($\frac{1}{6}$ gr.).**
3. **Pilulæ Laxativæ Compositæ.**—Compound Laxative Pills. **Dose, 2 pills.**
4. **Pilulæ Podophylli, Belladonnæ et Capsici.**—Pills of Podophyllum, Belladonna and Capsicum. **Dose, 1 pill.**
5. **Tinctura Belladonnæ Foliorum.**—Tincture of Belladonna Leaves. **Dose, 0.5 c.c. (8 ♏).**
6. **Unguentum Belladonnæ.**—Belladonna Ointment.

BELLADONNÆ RADIX.—Belladonna Root. **Dose, 0.045 gm. = 45 milligm. ($\frac{3}{4}$ gr.).**

Preparations.

1. **Fluidextractum Belladonnæ Radicis.**—Fluidextract of Belladonna Root. **Dose, 0.05 c.c. (1 ♏).**
2. **Linimentum Belladonnæ.**—Belladonna Liniment.

ATROPINA.—Atropine. **Dose, 0.0004 gm. = 0.4 milligm. ($\frac{1}{150}$ gr.).**

Preparation.

Oleatum Atropinæ.—Oleate of Atropine.

ATROPINÆ SULPHAS.—Atropine Sulphate. **Dose, 0.0004 gm. = 0.4 milligm. ($\frac{1}{150}$ gr.).**

ACTION OF BELLADONNA.

The action of belladonna is due to the atropine in it.

External.—Atropine by itself is not absorbed by the unbroken skin, but when rubbed in with absorbable substances, such as alcohol, glycerin, camphor, animal fats, etc., or when applied to abraded surfaces or mucous membranes, it has a well-marked local action and is also capable of producing systemic effects. Its chief local effect is a paralyzation of the sensory nerve terminations, so that it acts as an **anæsthetic** and **anodyne,** and it also depresses the motor nerve terminations, though less markedly, and tends to inhibit secretion. On the peripheral vessels it has first a constricting and then a dilating influence. Applied to the conjunctiva, it is a typical mydriatic.

Internal. *Blood.*—Atropine is rapidly absorbed into the blood, and it is stated to diminish the number of leucocytes.

Nervous System.—The main action of atropine is on the nervous system, and most of its effects in the organism are due to its influence upon the various portions of this. The action extends from the hemispheres downward, and in the medulla oblongata the drug first stimulates and then depresses the three principal centres. Its dominant and characteristic action is a **depression** of the **terminations** of most varieties of nerves.

Secretory Nerves.—On the activity of the peripheral terminations of all the secretory nerves in the body, it has, so far as known, a distinctly depressant effect. The secretions are not, however, all affected to the same extent, since with some of them the nervous influence is not so important as in the case of others. The secretion of **saliva** is entirely dependent upon the integrity of the nervous connection, and hence may be **entirely arrested** by atropine. Thus, in an animal under the influence of the drug, stimulation of the chorda tympani, which is the secretory nerve of the submaxillary gland, no longer causes an increased flow of saliva, as is the case under ordinary circumstances, and it has been shown by experiments excluding the participation of the ganglia and gland cells that the action is on the nerve endings. Furthermore, it has been shown that no paralysis results of the vaso-dilator fibres which extend side by side with the secretory fibres of the chorda tympani, the secretory fibres alone being selected by the atropine for its attack. In the same way the secretory nerve terminations in the other salivary glands and the buccal mucous glands are paralyzed, and as the normal impulses are thus prevented from reaching the gland cells, the mouth becomes dry. Even small doses of atropine will cause a considerable amount of dryness. From the same cause the secretion of the glands of the throat, nose and respiratory passages is stopped, and as a result there are produced **hoarseness** of the voice, **thirst** and **difficulty of swallowing.** The **skin** likewise becomes **dry** from the paralysis of the terminations of the nerves in the sudoriparous glands. While atropine **diminishes the secretion of milk** by the same process, it does not check its flow entirely, as the mammary gland has been found to continue to secrete after all its nerves have been severed. The solids of the milk are thought to be augmented rather than diminished. Recent investigations have shown that, by its action in paralyzing the terminations of the secretory fibres of the pneumogastric nerve in the stomach, atropine diminishes or may even entirely arrest the secretion of gastric juice. The pancreatic secretion, although it is not entirely dependent on nervous impulses, is similarly affected; so that after atropine the increased secretion which ordinarily occurs upon the entrance of food or of acid into the intestine does not take place, while stimulation of the pneumogastric, which ordinarily increases it, has no effect. The bile is also said to be diminished, and it would seem probable that the intestinal secretions are affected likewise. Some diminution in the urine, as well as an alteration in the proportion between its nitrogenous constituents, has been observed after atropine, but it is unknown how far such results may be due to its action on the kidney and how far to its effect on other organs. The amount of the urinary flow, as is well known, is largely dependent on the secretion of sweat. The flow of lymph is not affected by atropine, and from this fact it is inferred that this is not controlled by nerves in the same way as the true secretions.

Sensory Nerves.—The effect of atropine when locally applied in paralyzing the terminations of the sensory nerves has already been mentioned. The same local anodyne action is not observed from its internal administration, although some recent investigators have claimed that the sensory terminations are first stimulated and then paralyzed by the drug. It is said, however, that the frog may be rendered less sensitive to cutaneous irritation if poisoned with atropine.

Involuntary Muscles and their Nerves.—The innervation of all unstriped muscle seems to be **depressed or paralyzed** by atropine. Hence the movements of the stomach, intestine, bladder, uterus, spleen, bronchial muscle, thoracic duct, and of the pupil and œsophagus (except in animals in which these consist of striped muscle) are more or less diminished by it. In the intestine not only is normal **peristalsis lessened**, but that which is caused by direct nerve stimulation, as by electricity or drugs such as pilocarpine, is promptly arrested by atropine. Immediately after the injection of the atropine there usually occurs an increase in the intestinal movements. This might be cited as proof that it causes a preliminary stimulation of the nerve terminations, but may also be explained by the inhibitory endings being paralyzed earlier than the motor. Ordinarily the movements, although they become diminished, are not finally arrested, since the intestinal muscle, like the other involuntary muscles, is capable of maintaining a regular movement independently of nervous impulses from without. It is thus found that any irritating substance will cause peristalsis after atropine, and that the action of purgative drugs is not interfered with by it. It is a common practice to give belladonna in association with purgatives for the purpose of preventing griping, and the generally accepted explanation of this result is that the local contractions of the intestinal wall which are supposed to give rise to the griping are due to nervous influence, and hence disappear under the action of the drug. Very large quantities of atropine are said to paralyze the muscle of the intestinal wall, but this, it has been pointed out, could scarcely occur except under special conditions, as paralysis of the respiratory centre would undoubtedly precede it.

Voluntary Muscles and their Nerves.—Atropine has no direct action on the voluntary muscles. In the frog the terminations of the motor nerves are paralyzed by very large amounts, but it is said that this result has not been elicited in mammals by ordinary methods of experimental investigation.

The Eye and its Nerves.—Whether atropine be dropped into the eye or given by the mouth, it has the effect of **widely dilating the pupil.** This is due to paralysis of the **terminations of the motor oculi** nerve in the sphincter muscle. It is found that the paralysis is limited to the periphery, and that the muscle is not acted on is shown by the fact that it reacts to electrical stimulation. The pupil dilates because the elastic fibres of the iris have an opportunity to act. That the action is local is shown by its remaining confined to the eye, and even to that side of the eye to which atropine is directly applied, and also by the fact that it can be produced on the excised eye of a frog, and even on the isolated iris. There is also a **loss** in the power of **accommodation**, and this is caused by paralysis of the motor oculi terminations in the ciliary muscle. In consequence of it, near objects are no longer seen clearly. In addition, there is **increase of intra-ocular tension**, such as usually accompanies dilatation of the pupil, and this is supposed to be probably due to the dilatation. The dilatation is found to be not quite maximal, since it is generally increased, though but slightly, by stimulation of the cervical sympathetic trunk. In birds and reptiles atropine has no action on the iris, which in them contains striped instead of unstriped muscle.

The Heart and its Nerves.—The inhibitory **terminations of the vagus** in the heart are **paralyzed** by atropine. Consequently the heart-beat is **accelerated**, and stimulation of the vagus does not produce any change in it. In man the amount of acceleration produced varies considerably with the age of the subject, the vagus being most active in middle life. In the new-born infant there is no quickening of the heart, but up to about 30 the acceleration increases with the age, and from this point on lessens again. A second effect on the heart is often said to be a slight stimulation of the cardiac muscle by small doses, but there is reason to believe that the drug really has no such action. Large amounts undoubtedly weaken and depress the muscle, and may cause arrest in diastole. Furthermore, atropine has some **stimulating influence** on the **cardiac centres** in the medulla oblongata. This action, however, is for the most part overshadowed by the peripheral effects, though it may induce a preliminary slowing of the pulse. The circulation always persists after the cessation of respiration, and its failure is therefore not the cause of death in atropine poisoning.

Vaso-motor System and its Nerves.—Atropine causes a considerable **rise** in **blood-pressure**, an effect which is due in part to the acceleration of the heart-beat, and largely also to stimulation of the vaso-constrictor centre in the medulla oblongata, since it is much less marked after division of the spinal cord. This central stimulation has the effect of causing a contraction of the abdominal arterioles, which is accompanied by a dilation of the arterioles of the skin and probably also, it is thought, of the brain, from excitation of the vaso-dilator centre. Hence there results a movement of blood from the abdomen towards the periphery; but as the dilation of the cutaneous vessels cannot altogether counteract the constriction of the abdominal ones, a rise in blood-pressure is induced. The dilatation of the surface vessels is most marked in the region of the head and neck, where it causes a pronounced **flushing of the skin.** In many instances there is observed a rash like that of scarlet fever, and the hyperæmia may be so intense as to lead to desquamation. That it is due to central action is shown by the fact that it is prevented by section of the cervical sympathetic trunk. The increased arterial tension is maintained for some time after small doses, but large amounts soon bring about a **fall** in the **blood-pressure** by this action on the muscle fibre of the heart. Under toxic doses the pressure falls very low from paralysis of the vaso-motor centre and arterial muscles, as well as of the cardiac muscle. The spinal vaso-motor centres are acted on in the same way as the medullary.

Respiration and its Nerves.—The respiration is often slow at first, not, as was formerly supposed, from paralysis of the sensory peripheral filaments of the vagus in the lungs, but from some central action the precise nature of which has not as yet been explained. Soon, however, in consequence of stimulation of the respiratory centre in the medulla, the breathing becomes **quicker** and also probably **deeper,** and the amount of air inspired per minute is found to be considerably increased. Under large amounts of atropine the centre is rapidly **depressed.** The respiration grows shallower and slower, and in fatal cases **death** results from **failure** of this function. Not infrequently the breathing is interrupted by convulsive movements, and in many instances is then never resumed. Both the afferent and efferent terminations of the vagus in the lungs are paralyzed by atropine, and not only is the bronchial muscle relaxed, but the secretions, which are diminished in quantity, are now less irritating in consequence of the depression of the afferent filaments. In this way the drug has the effect of **lessening cough.**

Central Nervous System.—The action on the central nervous system consists of a true **stimulation, followed by depression,** and if the amount is sufficient, paralysis. While caffeine affects chiefly the higher divisions of the central axis, and strychnine the lower, the seat of the influence of atropine may be said in a general way to be intermediate as regards these. In the case of caffeine the highest functions of the cerebrum, the psychical, are involved first of all, but atropine acts principally on the motor divisions of the brain. It is likely to cause restlessness, vertigo, garrulity, incoherence of speech, staggering gait, choreoid movements, uncontrollable laughter or weeping, a busy delirium, and mania. In the subsequent paralytic stage, drowsiness, coma, and finally convulsions may occur, the latter largely from asphyxia. In the poisoning the medulla and spinal cord are involved, but in the cord the action is very much weaker than that of strychnine and appears much later. In the frog much the same effects are found to be produced by atropine as by the latter drug, because, the higher parts of the central nervous system being less developed than in mammals, the first symptoms observed are those arising from the cord. Young animals can bear much larger quantities of atropine or belladonna than older ones, and it has been suggested that the explanation of this is because the brain is less highly developed and the cerebral symptoms are therefore elicited less easily. It is also a fact that in the human subject **children** are much **less susceptible** to the influence of the drug than adults.

Temperature.—Atropine often causes a **rise of temperature,** which may amount to 2° C. (4° F.) or more. This has been attributed to a direct action on the cerebral heat centres, though it cannot be said that proof of such action is positively established, and seems to be independent of the blood-pressure and the diminished respiration, as well as of the convulsions. While the dissipation of heat is increased, probably because the flushing of the skin leads to a greater loss by radiation, the heat production is apparently increased to a still greater extent.

Elimination.—Atropine is excreted principally by the kidneys, but also passes into the milk and into the fœtal circulation. In herbivorous animals particularly it is excreted very rapidly in the urine. They exhibit a much greater tolerance of the drug than the carnivora or man, and this probably accounts largely for the difference. Rabbits, it is found, may be fed for weeks exclusively on belladonna leaves without presenting any symptoms of poisoning. Pigeons are also very insusceptible to the action of the drug. The uric acid of the urine is said to be diminished by it.

THERAPEUTICS OF BELLADONNA.

Externally.—Belladonna, and sometimes atropine, is used locally to relieve pain of all kinds, to check sweating and the secretion of milk, and to relax spasm, while atropine is employed to a considerable extent in ophthalmological practice. For neuralgia, myalgia, lumbago, acute inflammations, and chronic rheumatism and other painful affections of the joints belladonna is often applied in the form of liniment, ointment or plaster. For severe local pain atropine is sometimes combined with aconitine or other alkaloids. To relieve the pain of herpes zoster, and of irritable or malignant ulcers, cocaine hydrochloride, 1, with belladonna ointment, 100, may be of service. Belladonna is also useful in painful hæmorrhoids and fissure of the anus, to check the suppurative process in furuncle, abscess and carbuncle, and to promote the resolution of enlarged glands. The plaster is an excellent application to relieve the chest-pains of phthisis or to allay irritability of an over-excited heart. For inter-costal neuralgia or pleurodynia, strapping the chest with belladonna plaster is usually the most efficient way of applying the drug. In the form of the plaster or ointment it is much used as an antigalactagogue. A more elegant method is to envelop the breast in lint wet with a solution of atropine in rose-water, 1 to 120. The liniment, applied several times a day, is of great service in restraining excessive local sweating, and a lotion or ointment containing belladonna may be successfully employed in pruritus, urticaria and chronic eczema attended with much itching. In rigidity of the cervix uteri in the first stage of labor an old practice is to smear the os with extract of belladonna, but it is of very doubtful utility. A suppository containing the extract, alone or in association with opium, has been recommended in dysmenorrhœa dependent upon spasm of the cervix. It has been asserted that oleate of atropine makes a suppository of much more uniform composition than when extract of belladonna is employed. A solution of atropine in chloroform or in equal parts of chloroform and alcohol (1 part of the alkaloid to 100 of menstruum), applied to the epigastrium on a piece of lint, will sometimes relieve obstinate vomiting, cerebral or reflex, such as that of pregnancy, seasickness, etc. In ophthalmological practice atropine is used to dilate the pupil and relax the accommodation in order to facilitate examination of the eye and determine its refraction, and also to destroy adhesions and to prevent contraction of the iris or its protrusion through an ulcer of the cornea. The solutions of atropine for such purposes, as well as for hypodermatic injection, should be freshly prepared and sterilized each time, in order to avoid the development of penicillium in the liquid. Atropine sulphate is the salt commonly selected for dilating the pupil, and some such solution as the following may be employed: Atropine sulphate, 4; boric acid, 5; in water to 480. Atropine must not be used if the patient is suffering from glaucoma. In certain individuals even perfectly neutral solutions are very irritant, giving rise to what is known as atropine conjunctivitis, and the alkaloid also acts as an irritant in some cases of iritis, particularly those occurring in rheumatic patients with posterior adhesions. When belladonna is applied in the ointment or other form to open surfaces, the pupils and throat of the patient should always be carefully watched. Atropine sulphate is employed locally to a limited extent in diseases of the ear.

Internal.—Belladonna or atropine is given to check salivation from the use of mercury or other drugs and the excessive ptyalism sometimes met with in children and pregnant women. It is one of the best remedies known for the night-sweats of phthisis, and for checking this and other objectionable forms of sweating atropine sulphate (.006 gm.; $\frac{1}{100}$ gr.) may be injected hypodermatically, or .06 to .12 c.c. (1 or 2 ♏) of a solution of atropine sulphate in camphor water (1 to 100) given by the mouth. For bromidrosis of the feet and other localized sweatings also the drug may be used internally, as well as externally. It has been employed in serous diarrhœa on the ground that it tends to check this by stimulating the splanchnic vaso-motor filaments of the intestinal blood-vessels, the inactivity of which permits a transudation of liquid into the bowel. It is also given to overcome constipation and colic, and the extract of belladonna leaves is a frequent constituent of purgative pills. In peritonitis this extract is sometimes administered in frequently repeated doses in a pill with opium, for the purpose of paralyzing intestinal movements and thus assisting the action of the latter drug. In intestinal obstruction the propriety of administering atropine has given rise to much discussion. It is only in the paralytic and spastic forms that internal treatment would seem to be useful; in the former, small doses of atropine and in the latter large ones may be of service. In gastralgia, as well as the pain accompanying gastric ulcer, and in pyrosis, chronic gastric catarrh, and irritative dyspepsia, atropine often affords marked relief, and in cases of this kind it may usually be combined advantageously with small doses of zinc sulphate. Administered with dilute hydrochloric acid, it is useful in heart-burn, water-brash, etc. It may also be of service in the vomiting of pregnancy and other reflex varieties of vomiting, when given by the mouth, as well as when applied to the epigastrium. Sometimes it seems to be more efficient if used in suppository. Sick-headache due to or accompanied by spasm of the arterioles (as indicated by pallor of the face, vertigo and *tinnitus aurium*) is frequently relieved by belladonna. It is also of service in the headache of young persons, often due to over-work, in which there is pain in the eyeballs and forehead, with a sensation commonly described as a feeling that the orbits are too small for the eyeballs. This drug is a valuable remedy in many cardiac affections. Thus, as it accelerates the heart's pulsations without diminishing their force, it may be employed whenever it is desired to completely empty the ventricles. Its greatest service, however, is in relieving cardiac pain and distress. Here it may be applied over the præcordial region, as mentioned, or given internally, usually as the tincture of the leaves. It is also useful in the treatment of shock and collapse from injury or in the course of disease, and in pneumonia particularly it should be resorted to when after the crisis there is great relaxation of the vascular system and heart stimulants are found to be ineffective. Here the administration of atropine or belladonna will dry a moist skin and by increasing the vaso-motor tone often produce marked improvement. Given in full dose, it will not infrequently abort colds in which the pharynx is hot and dry and has a feeling of rawness, while the local capillaries appear injected and red. It is also of much benefit in acute coryza. In whooping-cough (where it should be given freely) and other spasmodic affections of the respiratory passages it has long been esteemed one of the most reliable remedies. For the symptom asthma it is of most service when combined with opium, and it may be given both during the attacks and as a prophylactic in the interval. Belladonna leaves rolled into cigarettes or put into a pipe are often smoked by asthmatics, but the most effective way of administering the drug here is the hypodermatic injection of atropine. In bronchitis with a tendency to paroxysmal spasm the tincture of the leaves is frequently associated with other remedies. The following is a very satisfactory mixture: Tincture of belladonna leaves, 3; vinegar of squill, 5; syrup of tolu, 10; glycerin, to 60 parts. For the nervous cough of both children and adults belladonna is an excellent remedy. It is also useful in laryngismus stridulus and in hiccough. Atropine has been used with good effect in the aphonia caused by fatigue of the vocal cords and likewise in hysterical aphonia. The utility of belladonna, when applied to the breast, for "drying up" the milk has already been mentioned. It is also of great service, employed both locally and internally, in cases of mastitis. Belladonna is probably the most efficient medicinal agent we have for the nocturnal enuresis of children, and is also valuable in urinary incontinence in adults when this depends upon vesical spasm. It relieves enuresis because it has an anodyne effect upon the centres in the cord, and, when excreted in the urine, anæsthetizes the neck of the bladder. It is also sometimes useful in the treatment of nocturnal seminal emissions. Its property of relaxing the spasm of involuntary muscle is well shown in the relief which it affords in the acutely painful vesical spasm which accompanies urinary calculus, cystitis and prostatitis. Here it may be employed in the form of a suppository or applied to the perineum in ointment or plaster, or it may be used both internally and externally. In urethral spasm and in chordee it may be given internally, and the ointment may be smeared along the under surface of the penis. By its action in relaxing spasm belladonna will also often give relief in the colic resulting from the passage of hepatic and renal calculi. On account of the similarity of the symptoms of atropinism with those of scarlet fever, belladonna has been vaunted as a prophylactic against this disease, but abundant experience has shown that the drug is absolutely valueless in this regard. It may, however, prove useful in relieving some of the symptoms of scarlatina, and is thought to be indicated when during the stage of eruption the pulse is feeble, the system much depressed, and the rash imperfectly developed. As ammonium carbonate is often prescribed in this condition of affairs, it must not be forgotten that these two remedies are chemically incompatible, and should not therefore be used together. Clinical observations go to show that in typhoid and typhus fever it is sometimes indicated, and may prove very beneficial when there is much low, muttering delirium, subsultus and stupor.

Although in the healthy individual this drug tends to induce wakefulness and busy delirium, yet in certain morbid states of the brain it appears to have a hypnotic action, and it is considered to be indicated in cases of mental disorder in which there are found a low state of the blood-pressure, deficient intracranial circulation, and a contracted pupil, with prostration and insomnia. Thus, a hypodermatic injection of atropine may overcome the insomnia of delirium tremens in cases where there are coma-vigil, great restlessness, and feeble heart-action, with coldness of the surface, blue skin, and a clammy sweat. Belladonna was formerly employed to a considerable extent in epilepsy, but its use in that disease has now been almost entirely abandoned, though it is still claimed by some that while in general it is vastly inferior in efficacy to the bromides, yet good results may sometimes be obtained from it in nocturnal epilepsy and *petit mal,* and in the case of anæmic subjects, with cold extremities, cyanosis, and weak heart. The subcutaneous use of atropine in neuralgia is of recognized value. It has been found particularly efficient in *tic douloureux* and sciatica, and to secure the best results it is advised that deep injections of the largest doses compatible with the safety of the patient should be made in the vicinity of the affected nerve-trunk. Atropine is also very highly recommended in peri-uterine and dysmenorrhœal neuralgia. In the treatment of neuralgia in general it is inferior to morphine, while its systemic effects are usually much more disagreeable than those of the latter. It should be resorted to more particularly in the case of patients who show an idiosyncrasy against morphine.

TOXICOLOGY.

Symptoms.—The most characteristic early symptoms of belladonna poisoning are dryness of the mouth and throat, dysphagia, and dilatation of the pupil, with dimness of vision. The skin is dry and the scarlatinous-like rash may or may not be present. The conjunctivæ are injected and the face is flushed, while the pulse is very markedly quickened and the temperature more or less elevated. There is often nausea, and sometimes vomiting. There may be purging, but this is not ordinarily observed. Frequently the urine is voided at an early period, and after that there is a constant desire to micturate without the ability to do so. It has been suggested that the preliminary contraction of the bladder is analogous to that of the intestine, and the subsequent inability to empty it to the diminution of the peristalsis. The patient staggers like a drunken man when he attempts to walk, and excitement, passing into delirium, is a prominent feature. The cerebral symptoms have already been sufficiently detailed. Convulsions are rare. The respiratory movements, which at first are slow and full, become quicker and shallower, from the depression of the medullary centre. The breathing grows dyspnœic in character, and death at length takes place from respiratory failure. A fatal ending, however, is comparatively infrequent. If the patient should survive, it sometimes happens that he has no recollection of his illness. *Post-mortem.* There is nothing characteristic about the appearances, which are simply those met with in asphyxia from any cause, the result of venous engorgement of the various internal organs.

Treatment.—Quite commonly the prognosis is favorable, as there is usually ample time for a successful treatment. The stomach should be washed out or evacuated with emetics (*see* p. 159). The general symptoms are best treated by the hypodermatic injection of pilocarpine and the delirium by the application of an ice-cap to the head. Chloroform or ether may be used to control spasms. In the stage of depression stimulants should be given subcutaneously and strong coffee by the rectum. Warmth must be applied to the surface and extremities, and artificial respiration may be called for. The effects on the eye may be counteracted by the local application of physostigmine, as well as by pilocarpine.

ANTAGONISM.

The antagonism between atropine and morphine is discussed on page 747. Morphine might, on theoretical grounds, be administered in the early stages of atropine poisoning, but its action on the respiratory centre renders its use dangerous in severe cases, for the stimulation caused by atropine soon passes into depression, and the effects of the two drugs would therefore supplement each other. As a sialogogue, diaphoretic and myotic, pilocarpine completely antagonizes the action of atropine on the secretory nerve endings in the salivary and sudoriparous glands and the terminal filaments of the motor oculi nerve in the iris and ciliary muscle. Contraction of the pupil and spasm of the ciliary muscle are also induced by physostigmine, which in like manner stimulates the motor oculi terminations, and it is furthermore antagonistic to atropine in that it at once has a depressant action on the respiratory centre.

HOMATROPINÆ HYDROBROMIDUM.—Homatropine Hydrobromide. **Dose, 0.0005 gm. = 0.5 milligm.** ($\frac{1}{125}$ **gr.).**

ACTION OF HOMATROPINE HYDROBROMIDE.

Its action appears to be much the same as that of atropine, but it is less poisonous and its mydriatic effects, while more rapidly produced, are somewhat less complete. It also has the effect of slowing, instead of accelerating, the action of the heart.

THERAPEUTICS OF HOMATROPINE HYDROBROMIDE.

It is largely employed for the purpose of dilating the pupil in ophthalmic practice, and it has the advantage over atropine that the mydriasis passes off in about one-quarter of the time. It is therefore better adapted for diagnostic purposes, while atropine is preferable when it is desired to keep the pupil dilated for some time, as in the treatment of iritis. It may be used in solution, 1 to 120 of distilled water. Sometimes a solution in castor oil is employed, as being less liable to be washed out by the tears, but this may produce some irritation.

STRAMONIUM.

STRAMONIUM.—Stramonium. (Thorn Apple. Jamestown Weed.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Extractum Stramonii.**—Extract of Stramonium. **Dose, 0.010 gm. = 10 milligm. (⅙ gr.).**
2. **Fluidextractum Stramonii.**—Fluidextract of Stramonium. **Dose, 0.05 c.c.; 1 ♏.**
3. **Tinctura Stramonii.**—Tincture of Stramonium. **Dose, 0.5 c.c. (8 ♏).**
4. **Unguentum Stramonii.**—Stramonium Ointment.

ACTION OF STRAMONIUM.

The physiological action of stramonium is practically the same as that of belladonna, though it is asserted that in poisoning by it irregularity of the heart's action is more marked. It also appears to relax the bronchial muscle more completely than belladonna. It is generally regarded as more toxic than the latter, and accidental poisoning by it, especially among children, is quite common.

THERAPEUTICS OF STRAMONIUM.

Stramonium might, apparently, be employed for all the various purposes of belladonna, but it is not very often used except to relieve the spasm of the bronchial tubes in cases where this produces the symptom asthma. Here it is of very great value. It may be given internally, but most commonly the fumes from the burning leaves are inhaled from cigarettes or otherwise, and the drug is more beneficial when used in this way. The following powder, when burned, is often very efficient in giving relief: Powdered leaves of stramonium, datura tatula (not official), cannabis indica, and lobelia inflata, of each, 12; nitre in powder, 16; oil of eucalyptus, 1. Mix thoroughly. Himrod's, Bliss's and other "cures" for asthma are of similar composition. Stramonium leaves are sometimes applied locally in poultices or fomentations for their anodyne effect, and the ointment is more or less used for irritable or malignant ulcers, hæmorrhoids, fissures and other painful affections, especially around the anus.

HYOSCYAMUS.

HYOSCYAMUS.—Hyoscyamus. (Henbane.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Preparations.

1. **Extractum Hyoscyami.**—Extract of Hyoscyamus. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

2. **Fluidextractum Hyoscyami.**—Fluidextract of Hyoscyamus. **Dose, 0.2 c.c. (3 ♏).**

3. **Tinctura Hyoscyami.**—Tincture of Hyoscyamus. **Dose, 1 c.c. (15 ♏).**

HYOSCINÆ HYDROBROMIDUM.—Hyoscine Hydrobromide. **Dose, 0.0005 gm. = 0.5 milligm. ($\frac{1}{128}$ gr.).**

HYOSCYAMINÆ SULPHAS.—Hyoscyamine Sulphate. **Dose, 0.0005 gm. = 0.5 milligm. ($\frac{1}{128}$ gr.).**

HYOSCYAMINÆ HYDROBROMIDUM.—Hyoscyamine Hydrobromide. **Dose, 0.0005 gm. = 0.5 milligm. ($\frac{1}{128}$ gr.).**

ACTION OF HYOSCYAMUS.

As may be inferred from the alkaloidal composition of the drug, the action of hyoscyamus is very similar to that of belladonna and stramonium. There are some particulars, however, in which it differs, though the difference is really one of degree rather than of kind. Thus, under atropine the primary stimulation of the central nervous system is usually very marked, while with hyoscyamus (an effect due to the influence of both its alkaloids) the stage of stimulation is much shorter, or may apparently be entirely absent. By its depressant action it may therefore produce drowsiness and sleep without any preliminary exaltation. Both hyoscyamine and hyoscine, as a rule, are

powerful hypnotics, and the sleep caused by them very closely resembles natural sleep. It is to be noted, however, that in some instances this is preceded by a stage of excitement, with confusion and garrulous delirium, as in the case of atropine, while occasionally the hypnotic effect is almost or altogether absent. In fact, they may have the opposite effect and cause insomnia. Hyoscine is even more depressant to the brain than hyoscyamine, and very small amounts are usually sufficient to induce sleep. As a rule, no confusion is complained of on awaking, but dryness of the throat and thirst are said to be often present. As regards the peripheral action, while inducing the same effects, it is believed that hyoscyamine acts somewhat more powerfully on the heart, intestine, pupil and sweat-glands than atropine, while hyoscine appears to have a still stronger action on the peripheral nerve terminations than hyoscyamine, and in man produces no distinct quickening of the pulse. Hyoscine is generally said to produce **mydriasis** and **loss of accommodation** more quickly than atropine, but for a shorter period, and according to some observers it acts five times more strongly on the pupil than that alkaloid.

THERAPEUTICS OF HYOSCYAMUS.

The preparations of hyoscyamus are weaker than the corresponding ones of belladonna, and accordingly must be used in larger doses. In general, the drug might be employed to fulfill any of the indications for which belladonna is used, but in practice it is almost exclusively given for two special purposes. As the peripheral action of its alkaloids is more powerful than that of atropine, it has more effect in preventing local contractions of the intestine depending upon nervous stimulation, and thus obviating griping, and hence it is very largely given with purgatives on this account. In the same way, it has a more marked sedative action on the urinary unstriped muscle than belladonna, and accordingly it is also much used to relieve vesical spasm in the same class of affections in which, as we have seen, belladonna is of service. It is very commonly prescribed with other urinary sedatives, such as buchu, uva ursi, or benzoic acid if the urine be alkaline.

Hyoscyamine and hyoscine are very powerful alkaloids and should always be administered with great caution, especially as the activity of different specimens varies. Hyoscine is the less dangerous of the two. Both are used as hypnotics to a considerable extent, and especially in hospitals for the insane. They often act very satisfactorily in cases of mania, delirium tremens, hysteria, etc., and may also be given for the delirium of fevers and for severe insomnia. Hyoscine is the one more commonly used; it is generally given by hypodermatic injection and is often combined with morphine. Some patients, it is found, are not quieted by the drug, but pace up and down in a semi-insane condition till its action has worn off. It is considered of great value in spermatorrhœa and seminal emissions. A certain degree of tolerance is produced by it, so that it is necessary to increase the dose from time to time in any case where its use is continued for some time. These alkaloids have been employed in chorea, paralysis agitans, locomotor ataxia, and a variety of other nervous affections, but apparently without permanent benefit. Hyoscyamine often temporarily controls very efficiently the tremor of paralysis agitans, and it is at times very useful in the treatment of the morphine habit, though it should not be given habitually in these cases. It is used to some extent in ophthalmic practice.

SCOPOLA.

SCOPOLA.—Scopola. **Dose, 0.045 gm. = 45 milligm. (¾ gr.).**

Preparations.

1. **Extractum Scopolæ.**—Extract of Scopola. **Dose, 0.010 gm. = 10 milligm. (⅕ gr.).**

2. **Fluidextractum Scopolæ.**—Fluidextract of Scopola. **Dose, 0.05 c.c. (1 ♏).**

SCOPOLAMINÆ HYDROBROMIDUM.—Scopolamine Hydrobromide. **Dose, 0.0005 gm. = 0.5 milligm. ($\frac{1}{128}$ gr.).**

ACTION OF SCOPOLA.

Scopola is a mydriatic, analgesic and hypnotic. Its action appears to be identical with that of belladonna in kind, though differing somewhat in degree. Thus, scopola is to some extent more depressant to the spinal cord and is decidedly more toxic. Like belladonna, it has been found to raise the blood-pressure, paralyze the vagus terminations, and primarily stimulate the respiratory centre, while in lethal amounts it causes death by asphyxia. In the frog it is stated to be a paralyzant to the spinal cord and to Setschenow's centre, and, when brought in direct contact with a motor nerve, to lessen its function. As regards effects upon the eye, scopola acts much more promptly, but for a shorter time, in dilating the pupil and slightly increasing the tension of the globe, while the systemic effects are more pronounced than from belladonna. The general conclusions which have been derived from a series of recent researches by a number of different investigators are as follows: While scopola is more depressing and toxic than belladonna, yet when administered externally it shows almost no tendency toward absorption to the extent of producing systemic effects. When it is absorbed, however, it acts locally with promptness and energy. As regards the eye, its effects are more rapid and less prolonged. In all the other ways experimented with it acts more efficiently, with the exception of the matter of plasters, where it is slightly less efficient than belladonna. Scopola exhibits a distinct superiority over belladonna root in its greater uniformity of alkaloidal percentages. [illegible] identical with hyoscyamine.

THERAPEUTICS OF SCOPOLA.

Scopola has been employed for a number of the same purposes as belladonna. It is to be noted, however, that while [illegible] scopola is nearly inert, when used by inunction in the form of the pure fluidextract or in liniments [illegible] more efficient than belladonna when [illegible] to dry the milk in breasts after weaning. It is advised that the drug should not be given when renal disease is present, nor in advanced age. Scopolamine hydrobromate [illegible] of from $\frac{1}{10}$ to $\frac{1}{4}$ per cent., in eye practice and by hypodermatic injection in hospitals for the insane.

ALCOHOL.

1. **ALCOHOL.**—Alcohol. (Ethylic Alcohol. Spirit of Wine.)

Preparation.

Alcohol Dilutum.—Diluted Alcohol. (Proof Spirit.)

2. **ALCOHOL ABSOLUTUM.**—Absolute Alcohol.
3. **SPIRITUS VINI GALLICI.**—Brandy.
4. **SPIRITUS FRUMENTI.**—Whiskey.
5. **VINUM ALBUM.**—White Wine.
6. **VINUM RUBRUM.**—Red Wine.

ACTION OF ALCOHOL.

External.—Alcohol is antiseptic and disinfectant, but it has comparatively little bactericidal action at the temperature of the body. 50 to 70 per cent. alcohol is said to be more destructive to germs than either stronger or weaker solutions. Curiously enough, it has been pointed out that many substances which are antiseptic when dissolved in water lose much of this property when dissolved in alcohol, and it seems to be an established fact that the presence of alcoholism, whether acute or chronic, actually predisposes to bacterial infection. This is a matter of common observation in the human subject, and has been demonstrated repeatedly in experiments on animals, whose power of resistance is diminished by alcoholization. Alcohol is both refrigerant and **rubefacient**, and is also astringent, anhydrotic and slightly anæsthetic. Applied to the skin, it quickly evaporates; thereby cooling the surface, with the effect of temporarily constricting the superficial vessels and checking the secretion of the sweat-glands. If, however, evaporation is prevented, as by covering the spot with a watch-glass or piece of rubber, or by rubbing the application in, the alcohol (which has the property of extracting water from all tissues) promptly absorbs moisture from the skin, and thus has the effect of hardening it. Having passed through the epidermis, it exerts an irritant action, similar to that of the volatile oils, which produces a dilatation of the vessels and redness, itching and a sensation of heat in the part. It also causes a temporary precipitation of albumins. Upon ulcers and abraded surfaces the irritant action is much more marked. The albumin is coagulated and there is first an astringent and afterwards a corrosive effect, until the alcohol becomes diluted by the fluids of the wound.

Internal. *Mouth.*—Upon the mucous membrane of the mouth and pharynx concentrated solutions cause effects similar to those on the skin when evaporation is prevented, but there is more of a **burning sensation** produced, and at once also there results, from reflex action, an increased flow of saliva and possibly a quickening of the pulse. Then follows a slight local anæsthesia, and if the alcohol is held in the mouth for some time, the mucous membrane becomes whitish and opaque, from coagulation of albumin and abstraction of water from the tissues. This soon disappears, as resolution of the albumin occurs.

Gastro-intestinal Tract.—In the stomach also a burning sensation is produced by concentrated solutions, and large quantities give rise to so much local irritation that nausea and vomiting are caused. In animals it has been demonstrated that alcohol, when given in moderate amount, induces, by its irritant action on the walls of the stomach, an increased cell activity, a more active circulation, and a more rapid secretion of both acid and solids of the gastric juice; also that gastric peristalsis is augmented and the absorption of fluids from the stomach and intestine much accelerated. In man the same effects have been observed in cases of gastric fistula, and it has generally been found by experimenters that the **digestion** is **promoted.** In some instances, however, in which observations on the duration of gastric digestion with and without alcohol were made, it was found that the process was retarded, instead of being accelerated, by this agent. To explain this discrepancy it has been suggested that the effect must vary in different individuals, and that it is not unlikely that the taste has some influence on the result; so that in those who enjoy the taste of alcohol it induces a more rapid secretion and an improved digestion, while in those to whom it is disagreeable, the secretion is inhibited. In general, it may be said that alcohol in moderate amounts tends to favor the process of digestion through an increased secretion of gastric juice, increased gastric movement, and increased absorption. With a percentage above 15, these are found to be counteracted by the lessened ferment action; so that the actual result will depend upon which of these two—the beneficial irritant or the deleterious anti-ferment action—predominates. Small amounts of weak alcohol taken at meals, it would seem, therefore, can scarcely have a bad effect upon digestion, and may be of service in promoting it. The primary effect of the irritation of the gastric mucous membrane is to **sharpen** the **appetite**, and this explains the quite common custom of taking a little alcohol just before meals. Furthermore, the **local anæsthetic effect** of alcohol may at times prove useful in **relieving** gastric **pain**. Alcohol is unique in one respect, no other known substance, it is said, having this effect: it causes the gastric glands to secrete when it is introduced into the small intestine or even into the rectum. It would seem, therefore, that it may act generally throughout the whole intestinal canal, to stimulate the flow of the gastric juice. In addition, alcohol by promoting the latter, indirectly promotes the pancreatic secretion also, since it has been shown that the chief stimulus to the flow of pancreatic juice is the action of the hydrochloric acid of the gastric juice upon the wall of the duodenum. The injection of a single dose of alcohol in concentrated form, as pure brandy, is immediately followed by pronounced **reflex effects.** Thus, the action of the heart is accelerated and increased in force, the blood-vessels generally, and particularly those of the skin, become dilated, giving rise to a feeling of warmth throughout the body, and the blood-pressure rises. The respiration is also quickened. These reflex effects, which are not produced by dilute forms of alcohol, such as beer, are well shown in the immediate restoration of a fainting person by a dose of brandy. They are quickly followed by the action on the circulation of the alcohol after its absorption into the blood. The repeated use of large amounts of alcohol leads to persistent congestion of the mucous membrane, and, if long continued, to chronic gastritis. The activity of the gastric juice is soon impaired and afterwards lost, the gastric glands atrophy, an excessive amount of mucus is secreted, and the permanent dyspepsia of drunkards results. In the intestines alcohol ordinarily has a **slightly astringent** effect. In drunkards, however, there usually results a catarrhal enteritis, as well as gastritis.

Metabolism.—About 90 per cent. of the alcohol absorbed from the alimentary tract is found to undergo combustion. In doing so it gives up energy to the body, and is therefore to be considered as a **food**, though the mere fact of its transmission of energy does not constitute it an advisable food in all conditions. Alcohol ceases to be a food when it is ingested in such large amounts that it cannot be completely oxidized. In this instance the excess is likely to be harmful. Taken in addition to the ordinary food, alcohol is either itself transformed into tissue, or undergoes oxidation in the place of some substance which in turn is utilized to build up the body. It has been shown that alcoholized animals lay on more fat than others receiving the same food without alcohol, and it is a familiar fact that in the human subject habitual drinkers evince a marked **tendency to obesity.** It is evident, therefore, that to some extent, at least, alcohol acts as a substitute for fats and carbohydrates in the food. While, however, it is well known that these principles can without any injurious effect be substituted for a certain amount of the nitrogenous food required by the system, it is as yet an undetermined question how far alcohol, although undergoing combustion in the tissues and leading to the deposition of fat, is able to replace the fats and carbohydrates in their relation to nitrogenous metabolism. As far as can be judged, it would seem that while alcohol really tends to prevent the waste of fats and carbohydrates, it is probably of less value than the latter in economizing nitrogenous waste; so that if alcohol is used as a food it should be associated with a diet rich in albuminous matter. Under these circumstances it is believed to be capable of replacing to some extent the ordinary food-stuffs. The only way in which alcohol, in moderate amounts, is supposed to have any action on the tissues is as a food, since the oxidation of the tissues, as measured by the absorption of oxygen and exhalation of carbon dioxide, is affected only in the same way as by any other food. When excessive quantities of alcohol are taken, the combustion of the tissues is first greatly augmented by the violent movements characterizing the stage of excitement, but later it becomes reduced from the lessening of the muscular movements in consequence of the stupor and depression induced. Naturally, fats are saved from combustion by the oxidation of alcohol by the tissues, and it is thought possible that in the case of some other bodies also, as benzene, the energy which would ordinarily be expended in their oxidation, is diverted to that of the alcohol. The observations on the effect of alcohol in moderate doses on nutrition have led to the following conclusions: (1) With a diet on which the individual gains in weight, the addition of alcohol lowers the rate of increase; (2) when added to a diet on which the weight remained constant, it tends to cause a loss of weight; (3) with insufficient diet, it lessens the loss of weight, or may even cause a gain.

Blood and Circulation.—On the leucocytes of the blood it has the effect of first augmenting and then reducing the amœboid movements; while as regards the red corpuscles it interferes with the ready yielding up of its oxygen by the oxyhæmoglobin, and thus tends to **retard oxidation** in the tissues. The reflex effects of alcohol on the circulation have been referred to in connection with its influence on the alimentary tract. Its action on the circulation after absorption has been the subject of much controversy. There is always a **quickening of the heart** during the excitement of alcoholic intoxication, but there is reason to believe that this is due to the increased muscular movement, rather than to any direct action on the heart. It has been shown that in normal cases the pulse-rate is unaffected by alcohol, provided that no excitement be produced by the environment, and this also remains unaltered in animals, unless a very large amount of alcohol is administered. In that case there are induced weakening of the auricular systole and afterwards of the ventricular, with distention of both cavities and slowing. It has been pointed out that these effects are similar to those caused by ether and chloroform, though the influence on the heart is very much less marked than in the case of these drugs. Whatever action alcohol has as regards the heart appears to be on the **cardiac muscle.** While it has been claimed that it increases the force of the contraction, proof of this is lacking, and, on the contrary, experiments on animals have indicated that the first effect of alcohol on the heart is diminished efficiency and weakness of the contractions. In alcoholic intoxication one of the most noticeable features relating to the circulation is the flushing of the cutaneous surface. This can be attributed only to dilatation of the vessels of the skin, but it is undetermined whether such dilatation is the result of stimulation of the dilator centres or paresis of the vaso-constrictors. This action apparently has very little effect on the general blood-pressure. A marked fall in this is caused by very large amounts of alcohol, which weaken the muscular tissue of the heart and depress the vaso-constrictor centres; but no such effect is to be expected from medicinal doses. In fever the heart is frequently slowed by the administration of alcohol, and the results of study of its influence on the circulation would seem to indicate that this is due to its effect in diminishing cerebral excitement, rather than to any direct action on the heart. In shock, whatever improvement in the circulation may follow the use of alcohol is to be attributed to the reflex influence from its local irritant action which has already been mentioned. It would appear that the reputation which alcohol has long enjoyed as a cardiac stimulant is not altogether supported by fact; but, at the same time, there can be no question that it is often of value in circulatory disorders for this reason, if for no other, that by its cerebral action it tends to lessen anxiety and other mental symptoms.

Respiration.—While experimenters now agree as to the main facts in the action of alcohol on the respiratory function, the interpretation of these is still a matter of dispute. During the excitement of alcoholic intoxication the **respiration** is usually **quickened,** and this may be due simply to the increased muscular activity, rather than to a stimulation of the respiratory centre in the medulla. Such excitement is not induced by therapeutic doses, but the evidence at command goes to show that without this the amount of air inhaled is generally increased by alcohol, and such increase has even been noted in some cases where a well-marked narcotic effect was present. At present it is impossible to say whether the augmentation of the air inhaled is due to direct action on the respiratory centre or to reflexes arising from the stomach, to both of which agencies it has been attributed by different observers. This is a question of practical importance in cases in which the respiration is insufficient, and not one of merely theoretical interest; for, it has been pointed out, if the augmented respiration is caused only by the local action in the stomach, this indicates that much of the surplus oxygen is used in doing the work of absorbing the alcohol, and that the rest of the body profits to a correspondingly small extent from the increased aëration. On the other hand, if the air inspired is augmented in a greater ratio than the products of the increased activity of the alimentary tract, as is the case when the respiratory centre is directly stimulated, the advantage to the organism is correspondingly great. On the whole, it would seem that while the use of alcohol as a respiratory stimulant is not actually supported by experimental investigation, it is nevertheless not to be entirely condemned.

Nervous System.—Alcohol is very generally regarded as a central nervous stimulant, which first excites and then depresses the cerebral and other cells. It should be stated, however, that the majority of experimental observers lean to the view that the stimulation is apparent rather than real. Their explanation of the cerebral excitement caused by alcohol is that it is due, not to the augmented vitality of the nerve cells, but to a loss of the associations which ordinarily retard the expression of mental activity. Their argument against the stimulant action of alcohol is based on the narrow limits to which this is confined. While it is true that all the central nervous stimulants act on some particular part, in small doses, it is found that when larger amounts are employed, the stimulant action spreads over a wider area of the central nervous system and gives rise to the symptoms characteristic of stimulation of that area. Alcohol, they claim, appears to have only a depressant action on the nervous tissues, except in the human cerebrum; though it is true that the exceptional development of the human brain might permit of a departure which is without analogy with other forms of poisoning. The conclusion arrived at by them is that the investigations thus far made point strongly to the correctness of the theory that alcohol really acts as a narcotic. The acceptation of this theory, they hold, is by no means equivalent to condemning the therapeutic use of alcohol for its effects on the brain, but, on the contrary, it is maintained that the narcotic or depressant action of alcohol, far from being in conflict with its clinical use, supplies a definite and logical explanation of the improvement noted in a large number of instances where the effect of alcohol in allaying the subjective symptoms, relieving the nervous strain, and promoting the rest and comfort of the patient is not surpassed by that of any other drug. Accordingly, it would seem a question whether the results aimed at by the clinician when he prescribes alcohol have not been misnamed stimulation, and are not in reality narcotic in their nature, and hence in entire agreement with the experimental results. The clinician, it is suggested, in applying the term stimulant to alcohol, uses the word in quite a different sense from that in which it is understood by the experimental observer—his meaning is less definite, and he wishes to indicate only the improvement often noted in the general condition, without considering whether this is due to an augmentation or a retardation of the mental processes. The view generally accepted in the medical profession is that alcohol is a powerful nervous as well as cardiac stimulant, and that the increased functional activity which it induces, especially in the nervous system, is followed by a period of diminished activity or depression; furthermore, that alcohol, like many other drugs, acts on the higher functions first, so that the stimulation and the subsequent depression proceed in a descending scale from the highest or least firmly fixed function to the lowest or most firmly fixed, in accordance with the law of dissolution (*see* p. 639). In the highest centres the special effect produced by alcohol appears to depend on the nature of their activity in the individual. In many individuals moderate amounts increase the facility of speech and in exceptional instances the brilliancy of thought. It must be acknowledged, however, that some of the highest functions of the brain are thrown out of action by doses of the drug which induce the phase of exhilaration. Thus, while a person may show greater brilliancy in conversation and generosity of sentiment, he is apt to lack that consideration for his own position or that of others which he ordinarily manifests, and to lose his self-control and self-restraint, his sense of responsibility and his power of discrimination. Such results would be explained, according to the stimulant theory, by the brief period during which the activity of the highest centres is augmented; so that the power of judgment becomes abolished very early, while the imagination, the emotions, and the power of speech are still in increased activity. These various functions then successively fail in the order named, and after them the muscular movements, commencing with the more delicate, become first incoördinated and then paralyzed. If the quantity of alcohol taken is sufficiently large, the reflex activity of the spinal cord next becomes abolished, and the bladder and bowels are evacuated involuntarily. The comparative immunity from injuries in falling, etc., which is often noted in drunken people, is believed to be due to the depression of the reflex centres of the cord, since the heart and respiration, on account of the general central depression, are not affected reflexly by them. After the spinal centres, the respiratory centre in the medulla fails, and finally the heart may be paralyzed and death result. A fatal issue of the poisoning, however, is exceptional, and generally recovery takes place after a prolonged sleep. This is deep and torpid, passing into total unconsciousness, with slow and stertorous breathing, while the face, which has hitherto been flushed, grows pale or cyanotic. If unconsciousness continues for more than ten or twelve hours, it is said that a fatal result is almost certain to occur. It has been conclusively shown that regiments supplied with alcoholic liquors are less capable of long marches and suffer more from fatigue than others without them, and, in addition, that the capacity for forms of work in which more mental activity is required than by marching soldiers is lessened by alcohol. Thus, when even a small quantity of alcohol is allowed, typesetters do a less amount of work and make a larger number of errors than when they are not supplied with it, while students exhibit a diminished capacity for mental work and less ability to keep the attention concentrated. The tendency toward sexual excess frequently observed after alcohol is not due to any influence upon the generative organs themselves, but to the loss of control from the cerebral action of the drug.

Temperature.—Small doses of alcohol have no effect on the body-temperature, although, in consequence of the dilatation of the gastric and cutaneous blood-vessels induced, they cause a sense of warmth both internally and on the surface. Moderate amounts (30 to 90 c.c.; 1 to 3 fl. oz.) **cause a fall** of 0.5° C., and this without causing intoxication. The reduction of temperature is believed to be due chiefly to a loss of heat from the dilatation of the cutaneous vessels. This is usually accompanied by a feeling of warmth, and a thermometer applied to the skin may actually show a rise of several degrees, in consequence of more warm blood flowing through the vessels. If much excitement and movement are caused by the drug, the increased heat resulting may counterbalance the augmented output; so that there may be no fall in the temperature, and in some cases even an elevation may be observed. Narcotic doses generally cause a fall amounting to from 3° to 5° C., which is due to the lessened movements during unconsciousness and may last for a considerable time. During exposure to cold a more marked reduction of temperature than under ordinary conditions appears to be caused by alcohol, in consequence, perhaps, of its rendering the heat-regulating mechanism less sensitive. Alcohol is, therefore, very unsuitable for a person who has to be exposed to severe cold. Besides, it causes drowsiness, and in this way dangerous results and even death may occur from a free indulgence in liquor under these circumstances.

Skin.—Alcohol is a mild **diaphoretic,** the action of the sweat-glands being augmented by the dilatation of the cutaneous vessels and also possibly by some direct influence on the glands.

Kidneys.—Alcohol has some **diuretic** influence, but it is unknown whether this is due at all to a direct action on the kidney. Some of the spirituous liquors, such as gin, induce free diuresis, but this is owing to the other constituents rather than the alcohol.

Excretion.—The small percentage of alcohol which is not oxidized in the tissues is excreted unchanged, principally by the lungs and kidneys and to a very much less extent in the sweat and milk. The exact amount thus eliminated varies with the quantity taken. If the amount ingested is very large, about 0.3 per cent. escapes in the milk, but if moderate, none. The popular notion that an infant may become intoxicated or acquire a taste for spirituous liquors from the alcohol absorbed in the milk of a drunken mother or wet-nurse is without any foundation in fact. Both the amount and quality of the milk are said to be unaffected by the administration of alcohol. When medicinal doses are taken, it is found that the quantity excreted through the lungs amounts to 5½ to 6½ per cent., and through the kidneys at most to 1 to 2½ per cent., while none is eliminated by the skin. Alcohol has been demonstrated in the blood for twenty-four hours after intra-venous injection of large quantities.

Tolerance is produced by the continued use of alcohol, and hence it is necessary to prescribe much larger doses in the case of habitual drinkers than for other persons.

THERAPEUTICS OF ALCOHOL.

External.—Alcohol is used as an evaporating lotion for sprains, bruises and local inflammations generally. A common form is the Lotio Spiritus, which is found in many hospital pharmacopœias, and which consists of 4 parts of alcohol to 1 of water. This is applied to the affected part upon a single layer of lint or cotton, and allowed to evaporate. Diluted alcohol, 3, with lead-water, 1, to which some morphine may be added if the pain is severe, is also employed in the same way. Headaches are often relieved by the refrigerant and anæsthetic effect of alcohol when used in the form of eau de Cologne to bathe the forehead, and spirit lotions, in consequence of their effect in constricting the cutaneous blood-vessels, may be of service in checking undue sweating. Brandy or ordinary alcohol is a good application for hardening the skin to prevent cracking of the nipples in nursing women and also for the prevention of bed-sores. Its efficiency for this purpose may be increased by the addition of a little alum. The rubefacient property of alcohol may be availed of for promoting the absorption of inflammatory products, or for the relief of pain in such affections as myalgia and chronic rheumatism, by rubbing it in the skin in the form of Linimentum Saponis and other liniments into which it enters. Hot applications of alcohol also alleviate pain, and a favorite method for securing relief in facial neuralgia, toothache, and various other painful conditions is the use of a flannel hop-bag which has been dipped in hot whiskey. A little brandy held in the mouth will also frequently relieve toothache. Properly diluted, alcohol may be employed as an astringent and antiseptic gargle or mouth-wash in pharyngitis, stomatitis, scurvy, salivation, etc. Port wine is very commonly used for this purpose. Concentrated alcoholic preparations are of service in the treatment of frost-bite, ulcers, loss of hair, freckles, and certain vegetable parasitic diseases.

Internal.—Used with careful discrimination, alcohol is one of the most valuable remedies we possess. It is not to be recommended in acute dyspepsia, as it is then apt to be irritant to the gastric mucous membrane, but given before or with the meals it is in many instances of service in sharpening the appetite and improving the digestion, especially in the sedentary, aged and feeble, and in cases of exhaustion from acute disease or over-work, where the stomach is naturally affected by the general condition. Sometimes it is best administered after eating. On account of its anæsthetic effect, alcohol, as has been mentioned, may relieve gastric pain, and it is also sometimes useful in allaying nausea and vomiting, particularly when given in the form of champagne or of brandy in small doses with pounded ice or effervescent mineral waters. When in delirium tremens nothing is retained on the stomach, so that the patient's life may be endangered on account of the lack of nutriment, a little brandy and ice will sometimes quiet the stomach, and thus enable it to receive and digest the food so urgently needed. In cholera infantum and in other diarrhœal affections, in adults as well as children, brandy is at times very useful, and port wine is also employed in diarrhœas. Alcohol may relieve intestinal as well as gastric colic, but gin and hot water has too often been relied upon by old nurses in the flatulence of infants and young children when proper attention to the feeding would have prevented the indigestion. Alcohol is of immense advantage in many cases of febrile disease, where during critical periods it sustains the vital powers by supplementing the insufficient quantity of nutriment which the system is capable of appropriating; at the same time stimulating the digestion, and thus enabling the patient to dispose of an increased amount of food. It is advisable under these circumstances, therefore, that it should be given with milk, broth, eggs or other suitable aliment. It is by no means adapted for all cases of fever, and hence its effects should always be very carefully watched. If under its use the pulse becomes stronger and fuller, the tongue and skin less dry, the respiration less embarrassed, the delirium and subsultus less marked, and the patient grows more tranquil and disposed to sleep naturally, we may know that the drug.is doing good. Although it is not given as an antipyretic, in cases in which it thus acts beneficially it will usually be found that the temperature is more or less reduced by it. On the other hand, if the fever rises and the other effects produced are the opposite of those just mentioned, the alcohol is doing harm and should be discontinued. While it is often given when it is quite unnecessary, there are many instances in which it is of inestimable value in such affections as typhoid and typhus fevers, pneumonia, small-pox, cholera and diphtheria, and also in gangrene, pyæmia, septicæmia, etc. It is likewise of the highest usefulness to arouse and support the flagging powers in sudden depression of the system, and may be given by the mouth, by the rectum, hypodermatically, or applied to the external surface with friction. It is thus resorted to in shock, syncope, severe hæmorrhage, and poisoning by tobacco, digitalis, antimony, conium, etc. In snake-bite and poisoning by phenol it may not only serve to tide the system over until the poison is eliminated, but also to directly antagonize the latter in the blood, and it therefore constitutes the best antidote in these cases. The beneficial effect of the reflex stimulating action of alcohol on the circulation is well shown in cases of fainting or collapse from cold or other cause, where a single dose of strong spirits often promptly revives the patient. Alcohol may be said to be indicated in general whenever adynamia is a pressing symptom, and should then always be employed, tentatively at least, unless there are special circumstances present which render its administration unadvisable. In acute disease frequently, and more rarely in chronic conditions, it is given with excellent effect in quantities which in health would cause intoxication and altogether disastrous results. The case is recorded of a young woman suffering from pulmonary tuberculosis who took one pint of whiskey daily for nearly two years and who finally recovered from the disease. In many instances of tuberculosis and other wasting diseases it is a remedy of the greatest service, lessening tissue-waste, promoting constructive metamorphosis, favoring the deposition of fat, and in general tending to retard the progress of the disease. The narcotic effect of alcohol on the nervous system may be employed to relieve pain, to promote sleep, and to quiet delirium, but except in the case of acute disease it should be resorted to for these purposes with the greatest possible discriminating judgment, on account of the patient's moral welfare. When given as a diuretic, it is usually in the form of gin, in which its effect is greatly augmented by the juniper contained in this liquor. Although but little alcohol is excreted by the kidneys, its abuse, particularly in the form of ardent spirits, is one of the recognized causes of chronic Bright's disease. In all inflammations of the urethra it seems to be irritating, and in the treatment of gonorrhœa is always interdicted to the patient. Beer is regarded as particularly harmful. Among the other contra-indications for the use of alcohol may be mentioned acute nephritis, all states of cerebral excitement, unless due to exhaustion, apoplexy, meningitis, aneurism, advanced atheroma, and the alcoholic habit. For its diaphoretic effect, a glass of hot spirits and water, taken at bedtime, is frequently employed to break up an incipient cold. In malarious regions it is a common practice to take whiskey with quinine as a prophylactic against intermittent fever.

TOXICOLOGY.

Very large quantities of alcohol are capable of causing instantaneous death by reflex arrest of the heart, but such a result is rare. Commonly they induce a torpid sleep, which gradually deepens into a condition like that seen in chloroform anæsthesia, and which may end in death, usually from respiratory failure. In some fatal cases convulsions have preceded death. When the patient is first seen in the advanced stage of deep coma, the absolute diagnosis of acute alcoholic poisoning cannot be made out.

Chronic Poisoning.—Among the more common results of chronic poisoning by the drug are chronic gastritis, cirrhosis of the liver, delirium tremens and mania. A great variety of other serious diseases have been attributed to its effects, among which may be mentioned gout, peripheral neuritis, pachymeningitis, organic heart disease, and chronic nephritis. There are, in fact, but few organs and tissues not in some way changed in chronic alcoholism, and its results, from their frequency and importance, have come to claim the attention of systematic writers on the practice of medicine. It need only be said here that the changes met with have been classified under two groups, sclerosis and steatosis. While these anatomical alterations are developing, the exterior of the body assumes characteristic appearances. The subject may either be pale and flabby, but fat, with a heavy and imbecile expression, or have a dusky red or purplish, pimply and bloated skin, with bulging under the eyes, yellow and injected conjunctivæ, and blue and swollen lips. Alcoholics are especially liable to contract pneumonia, tuberculosis and other infectious diseases, and when attacked by them show less powers of resistance than most other persons. They are also bad subjects for surgical operations. It is possible, however, that some of the bad effects resulting from the use of alcoholic drinks may be due to other substances than alcohol contained in them.

CANNABIS INDICA.

CANNABIS INDICA.—Indian Cannabis. (Indian Hemp.) **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Extractum Cannabis Indicæ.**—Extract of Indian Cannabis. **Dose, 0.010 gm. = 10 milligm. (⅙ gr.).**

2. **Fluidextractum Cannabis Indicæ.**—Fluidextract of Indian Cannabis. **Dose, 0.05 c.c. (1 ♏).**

3. **Tinctura Cannabis Indicæ.**—Tincture of Indian Cannabis. **Dose, 0.6 c.c. (10 ♏).**

ACTION OF CANNABIS INDICA.

External.—None.

Internal.—The action of cannabis indica seems to have many features in common with that of opium. Its **principal influence** is on the **cerebrum**, and it is regarded as perhaps the most powerful stimulant of the psychic functions known. It is largely employed for this purpose in the Orient (often in the form of *haschisch*), and its moderate use does not appear to be attended by any injurious effects. When taken to excess, it leads to tremor and loss of appetite and strength, and sometimes to mania and dementia. In some cases convulsive attacks have been observed, and among the natives of India catalepsy is said to occasionally occur. If the drug were generally used by Caucasians, it is thought that the effects would probably be more serious than is usual among Orientals. Death from acute poisoning is stated to be extremely rare, and recovery has taken place after enormous doses. At the same time, experiments on dogs have shown that it undoubtedly presents some danger. In the influence of cannabis indica upon the nervous system depression is mixed with the stimulation in a manner similar to that which is occasionally seen in the case of morphine. Within a short time after taking it the patient experiences the most pleasurable emotions. Everything seems to amuse him, and he becomes hilarious and indulges in actions which he may know to be ridiculous but which he cannot restrain. Double consciousness is now well marked; in fact the *ego* may become a severe critic of the *alter ego*. In the exuberance of his spirits he feels on the best possible, and even affectionate, terms with everyone about him. He passes into a dreamy, semiconscious state, in which, while the judgment is practically lost, the imagination runs riot. All his ideas are on a grand and magnificent scale; time and space seem to be indefinitely extended. He may say brilliant or witty things, but there is little continuity in his thought, which changes rapidly from one subject to another. Delightful visions pass before him in an endless phantasmagoria. True hallucinations are sometimes present. The general sensibility is much diminished, and this effect may deepen into complete anæsthesia.

The pupil is usually somewhat dilated. As the system becomes more profoundly influenced by the drug the dreams alternate with periods of consciousness, and eventually there results a tranquil sleep. From this the patient usually awakens without any feeling of depression, but refreshed and with an acute sense of hunger. Occasionally, in the midst of the pleasurable thoughts there is experienced a feeling of impending danger or other disagreeable sensation, and in some instances melancholia precedes the stage of sleep. In the Caucasian race the primary stage of exaltation may be quite short, and is sometimes altogether absent, deep sleep coming on after a preliminary feeling of heaviness and drowsiness, with noises in the ears and numbness of the extremities. It is a well recognized fact, however, that the effects of cannabis indica may vary greatly in different persons. This difference of action is due largely to individual peculiarities and also in part, no doubt, to the varying strength of the preparations of the drug. In man the heart is generally accelerated when cannabis indica is inhaled. In animals it is said that its intravenous injection slows the heart, partly through inhibitory stimulation and partly through direct action on the cardiac muscle, and that this action on the heart is the cause of death after poisonous quantities. In them the general effects appear to resemble those met with in man and also to present the same marked variations. There is sometimes observed a stage of exaltation with increased movement, and this is followed by depression and sleep. In dogs and cats vomiting is a not infrequent symptom. In frogs the reflex excitability is found to be first augmented and then depressed. While the habitual use of the drug in large amount may lead to grave psychic disturbances, it does not appear to cause constipation and the same disturbance of digestion and nutrition as opium. Some writers, however, assert that while a single dose does not usually produce constipation, and may even have a slightly laxative effect, after long continued administration there is a tendency to constipation both in man and in dogs. Dryness of the mouth, thirst, nausea, vomiting and strangury are untoward effects occasionally seen.

THERAPEUTICS OF CANNABIS INDICA.

While the physiological effects of this agent constitute a very interesting study, it is not of any great therapeutic importance, since almost any indication that it might be supposed to fulfill can be more satisfactorily and certainly met by other remedies. As a cerebral depressant it has been employed in a considerable number of affections, and in many of them it has been entirely abandoned. As a hypnotic it is unreliable, and, according to some authors, it produces sleep in only about 50 per cent. of the cases. In many instances there is excitement without sleep. It might be used, however, in certain instances in which opium is contra-indicated, and also as a substitute for opium in some mental diseases. As an analgesic it is sometimes of service. It has been given with advantage in cases of migraine and neuralgia, although it not infrequently fails to afford relief. In biliary colic it also sometimes proves successful. Cannabis indica enters into the composition of various preparations which are more or less used as anodynes and hypnotics and are sometimes of great service in bowel troubles. When prescribing the tincture, the resin from which is precipitated by the addition of water, it is necessary to employ mucilage to suspend it, while the taste is usually covered with spirit of chloroform.

2. **General cerebral depressants.**

OPIUM.

OPIUM.—Opium. **Dose, 0.100 gm. = 100 milligm. (1½ gr.).**

OPII PULVIS.—Powdered Opium. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Acetum Opii.**—Vinegar of Opium. (Black Drop.) **Dose, 0.5 c.c. (8 ♏).**
2. **Emplastrum Opii.**—Opium Plaster.
3. **Extractum Opii.**—Extract of Opium. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**
4. **Opium Deodoratum.**—Deodorized Opium. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

5. **Pilulæ Opii.**—Pills of Opium. **Dose, 1 pill.**

6. **Pulvis Ipecacuanhæ et Opii.**—Powder of Ipecac and Opium. (Dover's Powder.) **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

7. **Tinctura Opii Camphorata.**—Camphorated Tincture of Opium. (Paragoric.) **Dose, 8 c.c. (2 fl. dr.).**

8. **Trochisci Glycyrrhizæ et Opii.**—Troches of Glycyrrhiza and Opium.

OPIUM GRANULATUM.—Granulated Opium. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

Preparations.

1. **Tinctura Ipecacuanhæ et Opii.**—Tincture of Ipecac and Opium. **Dose, 0.5 c.c. (8 ♏).**

2. **Tinctura Opii.**—Tincture of Opium. (Laudanum.) **Dose, 0.5 c.c. (8 ♏).**

3. **Tinctura Opii Deodorati.**—Tincture of Deodorized Opium. **Dose, 0.5 c.c. (8 ♏).**

4. **Vinum Opii.**—Wine of Opium. **Dose, 0.5 c.c. (8 ♏).**

MORPHINA.—Morphine. **Dose, 0.012 gm. = 12 milligm. (⅕ gr.).**

MORPHINÆ ACETAS.—Morphine Acetate. **Dose, 0.015 gm. = 15 milligm. (¼ gr.).**

MORPHINÆ HYDROCHLORIDUM.—Morphine Hydrochloride. **Dose, 0.015 gm. = 15 milligm. (¼ gr.).**

MORPHINÆ SULPHAS.—Morphine Sulphate. **Dose, 0.015 gm. = 15 milligm. (¼ gr.).**

Preparation.

Pulvis Morphinæ Compositus.—Compound Powder of Morphine. **Dose, 0.500 gm. (7½ gr.).**

Heroina.—Heroine (unofficial). (Morphine Diacetic Ester.) **Dose, .003 to .012 gm.; 1/20 to ⅕ gr.**

Heroinæ Hydrochloridum.—Heroine Hydrochloride (unofficial). **Dose, .003 to .012 gm.; 1/20 to ⅕ gr.**

Action of Opium.

The effects of opium being due almost entirely to its morphine, the action and therapeutics of the two may be studied together. Codeine and some other alkaloids are considered later (*see* pp. 748 and 749).

External.—Though locally it has been said to possess feeble analgesic properties, opium probably has no action when applied to the unbroken skin; but from mucous membranes and raw surfaces it is absorbed, and it then exerts a marked anodyne influence. The latter, however, is due to the central action of the drug, as the sensory nerve endings appear to be in no way affected by it.

Internal. *Secretions.*—Most of the **secretions** are **diminished** by opium. The sweat, however, appears to be increased in consequence of dilatation of the cutaneous blood-vessels. Opium tends to check the secretion of saliva, but when nausea is caused, both the saliva and sweat are often markedly increased in consequence of this condition, rather than from any direct effect of the drug itself. It is noted also that in the last stages of opium poisoning the perspiration is sometimes profuse, but this is simply a result of the asphyxia. It is not known precisely what effect the drug has upon the bile or the pancreatic secretion. The urine is scarcely affected by it, though, in consequence of the absence of sphincter reflex, retention in the bladder not infrequently occurs. So far as known, all the other secretions are diminished.

Alimentary Canal.—Unless the dose is very small, dryness of the mouth and a feeling of thirst are promptly caused. Whether administered by the mouth or not, opium tends to produce **nausea and vomiting** and to **impair** the **digestion.** The nausea and vomiting would seem to be probably due in part to peripheral and in part to central action. When morphine is given by subcutaneous injection, it is quickly excreted into the stomach, and yet the great rapidity with which vomiting follows its administration in this way in dogs (in which this symptom is more constantly produced than in the human subject) points to an action on the medullary centre. Small quantities of opium lessen the sensation of hunger, and this is believed to be probably due rather to central action than to a local influence on the stomach. Because of the lessened perception of hunger and the gastric derangement, the appetite is diminished. In man and certain animals opium causes diminution of intestinal peristalsis and **constipation,** in consequence, probably, of some peripheral action. Not only does it tend to check the movement of the bowels, but it **abolishes or mitigates** abdominal **pain** when present. Very large doses cause violent peristalsis and diarrhœa in the dog, cat and, according to some observers, the rabbit.

Circulation.—Small doses have little or no effect upon the heart and circulation. With either large or small doses, however, there may be some quickening of the pulse at first, in consequence of nausea. Large amounts cause **slowing** of the **heart** through primary stimulation of the vagus centre in the medulla, as well as by an action on the cardiac motor ganglia. At the same time, from some obscure central action, the cutaneous vessels dilate. This gives rise to a **full pulse** and to a sensation of warmth in the skin, which may be followed by itching or discomfort, but has little influence on the general blood-pressure. The latter generally remains high, and the circulation is only greatly depressed quite late in the poisoning. While such depression is dependent to a considerable extent on vasomotor paralysis, it is no doubt largely secondary to respiratory failure. The heart finally stops in diastole, but death is rarely due to the effects of the poison on this organ or its nervous apparatus.

Respiration.—The respiration is slowed and at first deepened, but the increased depth is not sufficient to counterbalance the slowness of the breathing, so that the air inspired per minute is reduced. Later the respirations become not only shallow but irregular, and may assume the Cheyne-Stokes type. **Paralysis** of the **respiratory centre,** to which opium acts as a **direct poison,** is the ordinary cause of death. The bronchial mucus, like the secretions in general, is diminished by opium.

Nervous System. Brain.—The action on the cerebrum consists for the most part of a **depression** of the **higher functions.** In man, owing to the greater development of the brain, the narcotic effect of the drug is much more pronounced than in other animals. The depression is usually preceded by a **stage of excitement,** characterized by restlessness and increased mental activity, the length of which varies greatly in different individuals; but in some instances this appears [illegible] lacking. As a rule, it is found that the period of excitation can be maintained for a considerably longer time by the administration of small doses at frequent intervals, while under the effect of a single large dose it is short or absent, and deep sleep very soon comes on. During this first stage the imagination is often stimulated, the fancy has free play, and the creative powers are augmented, while the attention, judgment, coördination of the brain, and reasoning faculties are less keen than ordinarily. In exceptional instances, however, the intellectual power and mental vigor are increased. The general effect seems to be that of a **series of stimulations and depressions** going on at the same time, but whether these successively involve the same or different centres is unknown. Different parts of the brain appear to be affected in different degrees and at different intervals of time, so that, as held by some, these act in a dissociated manner and more or less independently of each other. It is well recognized that the symptoms are greatly influenced by individual susceptibility and by race, and among Oriental peoples the stage of excitement is generally much more prolonged than in Europeans. The motor areas of the brain are affected much more markedly in some animals than in man, and dogs, in which there is often noted a paralysis of the hind legs, are said to always exhibit a clumsiness in their voluntary movements which closely resembles that observed after ablation of these areas. In man it is often difficult to detect any evidence of stimulation of the cerebral motor centres, but the depression of these is never so pronounced as that of the intellectual faculties. It is true that the patient, in consequence of the debility and muscular weakness present, seeks a recumbent posture, but he can be walked about if he is supported. He feels in a most contented frame of mind, and sooner or later **sinks into a sleep** which is generally filled with dreams, often of the most fantastical character, though in some individuals it is entirely free from dreams. If the dose is large, the slumber is more apt to be dreamless. If it is not a poisonous one, the patient can be easily aroused, but under toxic amounts he soon sinks into complete coma. Opium is not only a powerful hypnotic, but the **most perfect analgesic** known. The dose required in any given case to annul pain naturally depends largely upon the severity of it. After small doses of the drug patients generally awake refreshed, though exceptionally there is a little languor, dryness of the throat, headache, and possibly nausea. In some instances the headache is quite severe and accompanied by nausea, vomiting and depression.

Medulla Oblongata and Spinal Cord.—The principal effect in the medulla is the profound depression of the respiratory centre. The other centres are much less affected, and in cases of fatal poisoning this is paralyzed before the centres of cardiac inhibition and vaso-constriction are depressed to any marked extent. There is, however, a distinct depression of the vomiting centre, so that, although vomiting may perhaps be at first induced by its transient irritation, emetics do not act well in opium poisoning. In man the spinal cord is but little affected except by large amounts. Mostly there is **depression** of its **conducting** and **reflex functions,** but in a few instances, after large doses, there have been observed increase of reflex excitability and twitchings or convulsions of spinal origin. In some of the higher animals there may be evidences of a similar action on the cord, but for the most part in mammals, after poisonous doses, the failure of the respiration closes the course of the intoxication. In the cold-blooded animals, however, there is found to follow a further development of excessive reflex irritability, which may pass into tetanic spasm. In the frog this reflex action is first diminished to a slight extent, and then increased to the same degree as by strychnine. In man opium sometimes has an aphrodisiac influence, and this has been attributed in part to stimulation of the cord and in part to the effect on the imagination.

Nerves and Muscles.—Except when given in enormous doses, the drug has no effect upon the peripheral muscles and nerves. Even when directly applied to the nerve, it has been found to have little influence on its irritability. Practically, therefore, opium has no action upon nerve fibres or endings. While in the frog the subcutaneous injection of large amounts of morphine may diminish the power of the end-organs to transmit impulses, this is not the case in mammals. In them the sensibility of the skin is lessened by an injection, but this appears to be a result of central action, since no more effect is produced at the point of application than elsewhere. In its general effect upon the nervous system opium affords a good example of the law of dissolution (*see* p. 639).

Pupil.—One of the characteristic effects of the drug is **contraction of the pupil,** and this is undoubtedly a central and not a peripheral action, since it does not occur after local application, nor after division of the nerve-trunks going to the iris. It is at once overcome by the application of atropine to the conjunctiva. After large doses of opium the pupil is reduced to the size of a pin-head, but in fatal poisoning it often becomes widely dilated shortly before death, as a result of the asphyxia. In birds, which are not much more tolerant of morphine, when given subcutaneously, than most mammalian animals, the pupil remains unaffected. In animals in which the drug causes movement and excitement, such as the cat tribe, it is widely dilated, while in some other animals, such as dogs and rabbits, it is affected in much the same way as in man.

Temperature.—Sometimes opium causes a slight preliminary rise of temperature. In most instances it occasions an inconsiderable fall, which is probably attributable to the lessened movement, as well as the dilatation of the cutaneous blood-vessels. Experiments on animals indicate that the heat centre in the brain is rendered less sensitive by the drug.

Skin.—As has been seen, opium causes some increased secretion of sweat, though its diaphoretic property is not usually very marked. As the effects of the drug are passing off, redness and itching of the skin are sometimes observed, and in susceptible individuals the erythema may lead to exanthemata, such as an eruption of small red spots resembling roseola.

Metabolism.—The metabolism is ordinarily lessened as a result of the quiet condition of the subject caused by the drug, so that the excretion of carbon dioxide is diminished in consequence of the depression; but in animals like the cat, in which great excitement is caused, its output is increased from the augmented muscular movement. There is also a lessened excretion of nitrogen. In consequence of the impairment of respiration, there may be an increase in the lactic acid of the blood and urine, and glycosuria may be present, while glycogen may disappear from the liver. In patients suffering from diabetes the amount of sugar in the urine is diminished. Transient albuminuria may occur after opium, and it has been suggested that this may possibly be due to vaso-motor changes affecting the circulation of the kidney. In chronic morphinism also there is diminished metabolism, but this is probably attributable for the most part to the derangement of digestion.

Excretion.—Opium is excreted chiefly by the digestive tract, in the salivary, gastric and intestinal secretions, and is found in large amount in the fæces. As morphine has been detected in the stomach in 2½ minutes after the subcutaneous injection of .03 gm. (½ gr.), there appears no question that the drug is capable of reabsorption from the gastro-intestinal tract. Traces of the drug have been found in the urine, but only after large doses. It is thought that a certain amount of it may perhaps undergo partial oxidation in the tissues, since oxidation products, such as oxydimorphine, have been observed in the urine. It is also excreted to some extent in the milk of nursing women, so that it may cause morphinism in the child. The substances which produce the characteristic odor of opium are excreted largely by the urine and less freely by the breath, sweat and milk.

Peculiarities.—Reference has already been made to the marked differences in the effects of opium in different individuals. In some instances, instead of having a soothing influence and putting the patient to sleep, it produces sleeplessness and excitement, which may amount to delirium. In others it causes marked nausea and vomiting, gastric pain, and indigestion, often with very severe headache. Some of these bad effects may very likely be due to the varying composition of the drug, but certain individuals present such a pronounced idiosyncrasy against opium that it cannot be administered to them in any form without very unpleasant results. Children are much more susceptible to its influence than adults, so that it must always be given to them with great caution, and women are, as a rule, more easily affected by it than men. Among the other untoward effects of opium may be mentioned diarrhœa, dyspnœa, aphrodisia, fever and hyperidrosis. Its effect in sometimes causing skin eruptions has been previously mentioned. The tolerance of the drug by the system is remarkable, so that persons who use it habitually are soon able to take enormous quantities with impunity, so far as any immediate danger to life is concerned. The explanation of the tolerance is believed to be the increased power of the organism to destroy the poison.

Differences in Action between Opium and Morphine.—A number of differences have been noted in the effects of morphine and opium. These are as follows: (1) Morphine is absorbed more rapidly, and hence acts more quickly. It is therefore especially adapted for subcutaneous injection, and, administered in this way, it produces its effects with great promptness. (2) Opium is more apt to interfere with the digestion, although it is claimed by some that it causes less nausea than morphine. (3) Opium is more liable to cause constipation. This is both on account of the greater local action of crude drugs as compared with alkaloids, and because it remains in the intestine for a longer time than morphine. Consequently, it produces a more pronounced effect there than elsewhere in the economy, and this fact is availed of in the treatment of many abdominal diseases. (4) Opium has greater diaphoretic properties. (5) Morphine is more certain, as well as more rapid, in its anodyne and hypnotic effects. (6) Morphine is less convulsant. (7) Opium is thought to have a stronger effect in reducing the sugar in the urine when glycosuria is present. (8) Opium affects the bladder sphincter less. (9) Morphine causes more pruritus. (10) Morphine is excreted more readily.

THERAPEUTICS OF OPIUM.

External.—Local applications of opium to relieve pain have long been in common use and are still often employed, but as it has been clearly shown that the drug has no effect on sensory nerve terminations, the practice must be regarded as simply a concession to a deeply-rooted popular sentiment, which has been handed down from the past. The apparent good results obtained are no doubt due for the most part to the absorption of the drug from wounds or mucous surfaces. When it is applied to the unbroken skin, there is either no benefit, or else such relief as is afforded is attributable to adventitious circumstances. Thus, it must be due to the heat, and not to the opium, when hot fomentations or poultices sprinkled with laudanum (a very common application) are employed. So, while Linimentum Opii (not official—tincture of opium and soap liniment, equal parts), rubbed into the skin, may be of service in chronic rheumatism, neuralgia, etc., it is probably the friction that is the principal factor in relieving the pain. The most popular form of this external use is the lead and opium lotion, and the probable explanation of its undoubted efficacy in sprains, contusions and other painful conditions is to be found in the non-irritating covering furnished by the lead precipitate and the astringent action of the lead itself. An ointment of nutgall and opium (powdered opium, 2; nutgall ointment, 27) is much used to relieve the pain of hæmorrhoids and anal fissures.

Internal. *Gastro-intestinal Tract.*—Morphine, which is here preferable to opium, is of much value in relieving the pain of organic disease of the stomach (ulcer and cancer), as well as of irritative dyspepsia. It may be given in solution (morphine, 1; water, 480; dose, 4 c.c.; 1 fl. dr.), and it is also much used in combination with bismuth, zinc and silver salts in painful stomach diseases. Opium is often of great service in acute gastritis, where it is advised that it should always be given in liquid form, preferably as the Tinctura Opii Deodorati. Many forms of vomiting, whether of peripheral or reflex origin, are checked by morphine, and it is likely to prove useful after the stomach has been emptied in cases of vomiting caused by irritant matters. In colic, and especially lead colic, it often relieves the pain without increasing the constipation; while allaying the spasm of the intestine, it does not appear to entirely stop its peristalsis. In diarrhœal diseases opium is of the greatest possible value, but it must be used with discrimination and judgment. In acute diarrhœa due to
food and in mucous diarrhœa it is advisable t

it the bowel should be cleared by a purgative. When the evacuations are watery, it may be combined with advantage with lead acetate or a mineral acid. In acute dysentery it is generally most efficacious after the preliminary administration of magnesium sulphate or other saline. It is frequently given by the rectum either in an enema with starch or milk or in suppository. In chronic dysentery it is the most reliable remedy, and may be employed in association with the salts of zinc, silver, copper or arsenic. In malarial dysentery, particularly, Patna opium, which contains over 6 per cent. of anarcotine, an antiperiodic, is especially indicated in combination with arsenic. In cholera morbus the hypodermatic injection of morphine is of great service, but in cholera infantum any form of opium must be used with great caution on account of the danger of producing narcosis. In cholera it is useless in the stage of collapse, but may prove of benefit in the preliminary diarrhœa, and it is an important ingredient of the various so-called cholera mixtures. In intestinal colic and abdominal pain of whatever origin opium generally affords relief, and it is largely used in the treatment of peritonitis and other inflammations and after operations or wounds of the abdomen. In severe abdominal cases it has been customary to push the drug to decided narcosis, without paying any attention to the constipation caused, but the more recent and better practice is to keep the bowels slightly open by the use of salines. When the full-dose opium treatment is employed in peritonitis, so that the paralyzing of the intestinal movements prevents the peritoneal surfaces from rubbing against each other, extensive adhesions are quite likely to result. As mercury is regarded by many as of special value in modifying inflammations of the serous membranes, particularly if combined with opium, it is a common practice to give calomel along with the opium, at least for a time. The following general caution has been suggested as one of great practical importance: As a rule, opium does harm in all gastro-intestinal affections in which there is a deficieney in the proper secretion, or a suspension of the functions, of the liver and kidneys. At the same time, the hypodermatic injection of morphine, by the action of the drug in relaxing spasm, is invaluable for the relief of the agonizing pain accompanying the passage of biliary and renal calculi, and is also of service in controlling the vomiting which is often present.

Heart.—It is quite probable that in small doses, administered hypodermatically, morphine is a cardiac stimulant. At all events, it often acts very happily in the pain and distress caused by disease of the heart, and its cautious subcutaneous injection may be tried in all forms of cardiac dyspnœa. It is especially indicated in those cases in which the patient, while perhaps able to breathe quite easily when awake, suffers from marked distress as soon as he falls asleep. Opium or morphine given by the mouth are usually much less efficient in affording relief in heart-trouble than morphine administered in this manner. The pain of aortic aneurism and intra-thoracic growths, like pain in general, is relieved by morphine. It is quite customary to give the drug in association with small doses of atropine, as it is found that its analgesic effect is rather increased than diminished thereby, while the sleep resulting is less disturbed and more nearly approaches normal sleep. In addition, the atropine serves to counteract some of the depressing effects upon the heart and respiration and also to largely prevent subsequent headache, vertigo and nausea, as well as constipation. It has been shown that in the use of chloroform for anæsthetic purposes a hypodermatic injection of morphine just before the inhalation begins prolongs the stage of narcosis with a less quantity of chloroform, diminishes the danger of cardiac paralysis, and tends to prevent the after-nausea and depression. The same is true as regards other anæsthetics, and especially in the case of persons addicted to alcoholic stimulants and of exceptionally neurotic patients does the preliminary morphine injection render the anæsthetization safer and favorably affect the stage of recovery.

Vessels.—Although not acting directly upon the vessels or blood, opium is most valuable as an internal hæmostatic. This effect is largely in consequence of the quietude secured by it, which allows the blood to coagulate in ruptured vessels. When, as is frequently the case, the hæmorrhage is attended by marked restlessness, the drug is absolutely indicate sedative effect both on mind and body. It is especially efficacious in gastric and intestinal hæmorrhage, where its influence in diminishing peristalsis is of material service, and also in pulmonary hæmorrhage. In hæmatemesis and hæmoptysis the benefit derived from it is in no small measure due to its controlling of vomiting and coughing, both of which are apt to bring on fresh bleeding. A very good preparation to use is powdered opium in combination with lead acetate as a pill. Hypodermatic injections of morphine are preferred by some, and when these are used they should be repeated at regular intervals as long as further hæmorrhage or the risk of it continues.

Respiration.—Opium, on account of its depressant effect upon the medullary centre, must be given with caution in respiratory diseases, but in well selected cases it is of marked benefit. An incipient catarrh may often be aborted by a full dose of Dover's powder. In bronchitis with excessive secretion very small amounts of opium may be sufficient to diminish its amount, as well as allay cough. If, however, the secretion is scanty and tenacious and expectoration difficult, opium may aggravate rather than relieve the condition. In pleurisy and pneumonia it is often of great service in controlling cough and relieving pain, but the tendency to asphyxia in serious diseases attended with cough must always be borne in mind. Opium should therefore never be used in the last stages of pneumonia and bronchitis. By its antispasmodic properties it is frequently efficient in arresting the symptom asthma, but its use here is objectionable on account of the danger of inducing the opium habit. It is a very frequent and useful ingredient of expectorant mixtures, and among the preparations commonly employed in the treatment of cough are paregoric, Dover's powder, compound liquorice mixture, and the compound morphine powder. Codeine (*see* p. 748) is preferable to all other preparations and alkaloids of opium for relief of cough in pulmonary diseases. Heroine (*see* pp. 729, 744) is also very much used for this purpose at the present day. To relieve the pain of tuberculous or other organic disease of the larynx an insufflation may be used consisting of morphine acetate, .06 gm. (1 gr.) and .30 gm. (5 gr.) of starch, with or without .06 gm. (1 gr.) of iodoform or boric acid. As the morphine produces its action only after absorption, however, other agents have a more prompt and efficient local anæsthetic effect. The intra-laryngeal application of menthol and orthoform constitutes one of the best means of affording relief in these cases.

Nervous System.—Opium is unrivalled in its influence in relieving pain from whatever source and in inducing sleep when insomnia is due to pain. For these purposes the hypodermatic injection of morphine is usually preferred, as acting more promptly and certainly and less liable to cause nausea or digestive disturbances than opium or morphine given by the mouth, and atropine sulphate is often added to the solution injected for the purpose of minimizing as far as possible any ill-effects of the morphine salt. Morphine is of great value in relieving the after-pains of labor, and may be of service in spasm of the bladder sphincter and spasmodic stricture of the urethra by its action in relaxing the muscular contraction. Opiates are also commonly resorted to in cases of threatened abortion. It is manifestly impossible to more than hint at the almost unnumbered applications of opium or morphine as an analgesic and hypnotic, but it is obvious that its use should as a rule be restricted to acute or rarely recurring conditions, on account of the very great danger of the patient's contracting the opium habit. For the relief of pain and insomnia in incurable diseases, however, the judicious employment of the drug for an indefinite period is entirely justifiable. Enormous doses are often borne by patients suffering from very severe pain without the development of any indications of poisoning. Morphine is sometimes an efficient sedative in delirium tremens and other forms of mania, but not infrequently such large quantities are required as to render it an unsafe remedy. In acute mania small doses are said to be the most efficient if the arterial tension is low, but if the pulse is quick and the blood-pressure high, the full effect of the drug is necessary. Large hypodermatic doses require the utmost circumpection, especially in obese and aged subjects. In delirium tremens hydrated chloral is usually a more satisfactory hypnotic than morphine
excellent results have been claimed f
small or stimulant doses, and her

istration is the tincture. There is reason to believe that the hypodermatic injection of morphine is of great value in many cases of puerperal eclampsia, and its use appears to be growing in favor. It has also been advocated for the relief of uræmic convulsions when due to acute nephritis, whether puerperal or not, on the ground that it tends to arrest muscular spasms by counteracting the effect of the poison on the nerve-centres, to establish profuse diaphoresis, and to facilitate the action of cathartics and diuretics. In hysteria it is not as efficient as various other remedies, and is especially objectionable from the risk of its inducing the opium habit. In pachymeningitis and basilar meningitis opiates in small doses seem to accomplish more than other remedies, and the hypodermatic injection of morphine in quantities sufficient to relieve the pain and rigidity is considered of value in the earlier stages of cerebro-spinal meningitis. When effusion has taken place and stupor and coma supervene, opiates are no longer of use. In conditions of increased excitability, such as tetanus, strychnine poisoning, and epilepsy, opium has been found on the whole to be harmful rather than beneficial. Still, in a large number of affections it is one of the most efficient of all remedies for relieving spasm, and its admirable action in this capacity has been incidentally referred to in several classes of cases. It may be mentioned here that severe hiccough is very commonly arrested by a hypodermatic injection of morphine. As opiates are as completely absorbed from the rectum (if the latter be thoroughly cleared) as from the stomach, it is often advantageous to administer them in enemata or suppositories. Since the absorption is slower, however, the dose should be twice or possibly three times as large as when they are given by the mouth. In surgical practice opium has always been widely used to prevent or mitigate shock, as well as to relieve pain and check or alleviate inflammation. Its uses in surgery can only be briefly referred to in passing, but there seems to be no question that it not only relieves existing shock, but is a potent factor in the prevention of secondary shock. It is the first remedy called for when pain or hæmorrhage is present, and the hypodermatic injection of morphine is strongly indicated in shock following injury, especially if an operation is required. It is an inestimable boon in severe burns, and it is particularly indicated in fractures, where it not only allays the immediate pain, but brings about muscular relaxation and relieves many distressing symptoms. It is not uncommon now to hear surgeons decrying the use of opium under almost any circumstances, but while its careless and unscientific employment has brought this powerful therapeutic agent into more or less disrepute, there can be no doubt that it will still continue to occupy the highest position in the estimation of those who use it judiciously,

Kidneys.—It is probable that the feeling which has existed against the use of opium when Bright's disease is present has been due to the idea that the impaired state of the kidneys prevents the proper elimination of the drug; but since it has been conclusively shown that only the faintest traces, if any, are normally excreted by these organs, it would seem, from a theoretical point of view at all events, that there is less risk in its employment in this class of cases than has generally been supposed. As a matter of fact, however, several instances of chronic nephritis are on record in which death was apparently caused by quite small doses of opium. It is the part of prudence, therefore, to use it with great caution in cases of chronic Bright's disease. Still, ample justification is afforded for its judicious employment, notwithstanding the apparent risk, by the marked relief which often attends the hypodermatic injection of small amounts of morphine in the uræmic dyspnœa, uræmic insomnia, and cardiac dyspnœa so likely to be met with in the course of this affection. Its employment in uræmic convulsions has already been referred to as limited to cases due to acute nephritis.

Skin.—Dover's powder is of considerable utility as a diaphoretic. It is commonly given in acute muscular rheumatism, and at the onset of "colds" and febrile attacks of various kinds, and will often effect a cure, particularly if its action is aided by hot drinks and a hot foot-bath.

Metabolism.—Opium and its derivatives are acknowledged to have a favorable effect in many cases of diabetes, not only materially diminishing the amount of sugar in the urine, but also often causing an amelioration in the general condition of the patient. Codeine is undoubtedly the most serviceable form in which to employ the drug in this disease. Opium has apparently a beneficial influence, the precise nature of which is not very clear, in all sorts of inflammations, and it is thought to be particularly efficacious in those of the serous membranes.

Heroine (not official), which as a hydrochloride is freely soluble in water and alcohol, generally produces no disagreeable symptoms, beyond headache, and is stated not to give rise to habituation. A more extended knowledge of the drug, however, would seem to indicate that the latter assertion is not entirely correct. It occasionally produces violent and uncontrollable vomiting. Since it diminishes the sensitiveness of the respiratory centres to an excess of carbon dioxide in the blood, it is useful in some forms of dyspnœa. It is of great value in quieting cough.

TOXICOLOGY.

Acute Poisoning.—The symptoms usually appear in from ten minutes to one hour after opium has been taken by the mouth. As might be expected from the effects of the drug upon the central nervous system, they are those of profound narcotism. Drowsiness may or may not be preceded by some slight excitation, and as a rule it supervenes very quickly. The drowsiness passes into sleep, from which the patient may be roused, but soon this deepens into stupor and eventually into complete coma, in which reflex excitability is abolished and no stimulation of any kind has the slightest effect. A characteristic phenomenon is the extreme contraction of the pupils. The countenance, at first flushed, becomes pale and then cyanotic, while the lips are livid. The general surface is cold, and as the poisoning advances becomes bathed with prespiration. In the earlier stages the pulse is apt to be full, slow and laboring; later it becomes so weak as to be almost imperceptible. The breathing gradually grows slower and more stertorous, as well as irregular. The limbs are relaxed, but death, which, as mentioned, is due to respiratory failure, may possibly be preceded by asphyxial convulsions. The fatal result may occur in from two to ten hours. Even when coma and convulsions have developed, recovery is possible, and in that case the coma passes into a condition of slumber which not infrequently lasts for from twenty-four to thirty-six hours. The patient is then apt to suffer from much nausea, headache and nervousness.

Diagnosis of Poisoning by Opium.—(1) *From Alcoholic Poisoning.*—This is often very difficult, especially when the patient has taken alcoholic stimulus, and it is important that a correct history of the case should be obtained, if possible. Points of difference are that in opium poisoning the pupils are more minutely contracted and the patient can be roused with less difficulty. The breath usually has a characteristic odor after opium (though not after morphine), but this may be obscured by the smell of alcohol if this has been taken. An examination of the urine may perhaps be of service in determining the true condition present (2) *From Cerebral Hæmorrhage.*—If the pupils are unequally dilated cerebral hæmorrhage is present. If such hæmorrhage has its site in the pons Varolii, the resultant contraction of the pupils may render the differential diagnosis very difficult, and local paralysis should be carefully looked for. When hemiplegia is present, the recognition of cerebral hæmorrhage is easy. With a small hæmorrhage, and especially in the pons, the temperature may be elevated, while with a large one, this is lowered for the first few hours, though it may rise afterwards. (3) *From Phenol Poisoning.*—While here there may be coma and contraction of the pupils, the characteristic odor of the acid is present and its caustic effects may be observed upon the mucous membrane of the mouth. The urine is dark and smoky, and gives little or no precipitate with barium chloride. (4) *From Chloroform and Ether Poisoning.*—The smell of the breath and of the matters vomited will be a sufficient indication that the coma is due to one of these drugs. (5) *From Uræmia.*—In uræmia the presence of albuminuria, even if no other sign of Bright's disease can be detected, will show the nature of the case. The odor of the breath is also characteristic in uræmia. (6) *From Diabetic Coma.*—Here the odor of the breath is likewise characteristic, and sugar will be found in the urine. (7) *From the Comatose Stage of an Epileptic or other Fit.*—In this condition the lividity of the face does not become progressively more marked, and the pupils are as a rule dilated. The history of the case, if obtainable, is also of service.

Post-mortem.—The appearances are simply those characteristic of asphyxia. If death is due to opium, and not its alkaloids, the odor of the drug may be detected. The condition of the pupils varies in different instances. The gastric mucous membrane is sometimes found to be reddened.

Treatment.—The stomach should be washed out, not merely once, but repeatedly and at short intervals, because the morphine which has been absorbed is excreted into the stomach. On this account the evacuation of the latter is called for whether the drug has been taken subcutaneously or not. Prompt emetics (*see* p. 159) should also be given, and especially apomorphine hydrochloride hypodermatically. If narcosis has already set in, however, the action of emetics may be materially interfered with. Potassium permanganate, well diluted, has been successfully used in an amount equal to that of the alkaloid ingested; it almost immediately destroys the latter, through its chemical action. It is claimed that it can act upon the poison when in the blood, so that a hypodermatic injection of it even for some hours after its ingestion may afford relief. This has been denied, however, and it would seem probable that it is efficient only on that part of the poison present in the stomach. The reports have been so generally favorable that potassium permanganate should be used immediately. It has been recommended that atropine sulphate (.003 gm.; $\frac{1}{20}$ gr.) should be given hypodermatically, or tincture of belladonna (2 c.c.; 30 ♏) by the mouth, and repeated every fifteen minutes; but great caution must be exercised with the use of this antidote—if, indeed, it should be employed at all. Instances of recovery from opium poisoning followed by death from the belladonna or atropine given as an antidote have been observed. Some advise that .006 gm. ($\frac{1}{10}$ gr.) of atropine sulphate should be given as soon as possible, and not repeated. Caffeine, especially in the form of strong, black, hot coffee, is one of the best antidotes, and given in this way the tannin is also useful. Coffee may be administered by the mouth, and an enema of it (500 c.c.; 1 pint) should also be given. Every effort should be made to rouse the patient and keep him awake, especially by walking him about, as the constant movement contributes to the better tone of the medullary centre. Flapping with a towel, pinching, etc., may also be restored to, as well as such general reflex stimulants as the application of the faradic current, cold affusions, the inhalation of ammonia, and the hypodermatic injection of ether. The patient should be kept warm, and artificial respiration may be called for. Oxygen or amyl nitrite inhalations are sometimes of service. The treatment must be kept up for several hours, if necessary.

Chronic Opium Poisoning.—Chronic poisoning is, unfortunately, quite common, opium (usually in the form of laudanum or pills) being taken habitually by the mouth, or morphine by hypodermatic injection. The effects of the prolonged use of the drug, mental, moral and physical, are most deplorable. The symptoms, however, are more or less indefinite, and some individuals appear to continue the habit for many years with comparative immunity. Usually the patient loses weight, becomes anæmic, and suffers from loss of appetite and indigestion. The bowels may be continuously constipated, or constipation may alternate with diarrhœa. The pupils are contracted, the skin and tongue dry, and the nails brittle, while the hair turns prematurely gray and falls out. The heart is apt to be irregular, and muscular tremors and unsteadiness of gait are often observed. The patient is nervous, lacking in energy and will-power, and entirely unfit for work of any kind. He is utterly untrustworthy in his statements, and becomes lost to all sense of honor and uprightness; lying in the most bare-faced manner and even committing theft, if necessary, in his endeavors to obtain the drug. Sexual impotence is a common result, and melancholia and dementia may eventually supervene, especially when morphine is used. In morphine *habitués* the arm, leg, or front of the body will usually be found to be scarred with marks of the needle. The craving for the drug is so intense that the patient suffers agonies when temporarily deprived of it, and it becomes necessary for him to increase the dose from time to time in order to secure the desired effect. The daily quantity of morphine used is thus often exceedingly large. The practice of opium smoking, the method of employment in vogue among Oriental peoples, appears to be less harmful in its results than the prolonged use of opium by the mouth or morphine by subcutaneous injection.

Treatment.—The treatment of chronic poisoning is attended with immense difficulties, especially on account of the degraded moral condition of the *habitué*, and is very often unsuccessful in effecting a cure. As a rule, the patient should be isolated, and watched with the greatest vigilance to prevent his securing the drug surreptitiously. The morphine must not be withdrawn suddenly, as this is likely to be attended by collapse and aggravated mental disturbance, but the dose should be gradually diminished until it is deemed judicious to stop it altogether. There is no known drug which seems to have any curative effect, and the results of substituting agents such as cocaine for morphine have always proved disastrous. No reliance can be placed upon any of the advertised cures for the morphine habit; most contain morphine and the remainder are useless. The patient on entering an institution for his cure must be most thoroughly and carefully searched so that he shall not be possessed of a supply sufficient to keep him comfortable during his treatment.

Atropine.—Atropine (*see* p. 692) is a valuable antidote to morphine, especially from the fact that it powerfully stimulates the respiratory centre, and also because it tends to antagonize the depressing effects of this drug upon the cerebrum and upon intestinal peristalsis. At the same time, as mentioned above, the danger of substituting belladonna for opium poisoning must always be borne in mind. While appearing to be antagonistic in some other respects, this is really not the case. Thus, although it arrests perspiration and dilates the pupil, it produces these effects by its action on the peripheral nerve terminations, while the opposite effects caused by morphine are due to action on the central nervous system. Still, it is found that in giving morphine by hypodermatic injection, certain of

such as indigestion, constipation and cardiac depression may be prevented or rendered less marked by combining atropine sulphate (.0004 to .0006 gm.; $\frac{1}{150}$ to $\frac{1}{100}$ gr.) with each dose.

CODEINA.—Codeine. (Methyl Morphine.) **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

CODEINÆ PHOSPHAS.—Codeine Phosphate. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

CODEINÆ SULPHAS.—Codeine Sulphate. **Dose, 0.030 gm. = 30 milligm. (½ gr.).**

Action of Codeine.

Codeine is much less toxic than morphine, which it somewhat resembles in the general character of its action. While it is powerfully analgesic, however, its hypnotic influence is quite limited. Small doses induce light sleep, but somewhat larger ones are apt to cause restlessness and more or less exaggeration in the reflex excitability. It is much less depressant to the higher cerebral centres than morphine, and has a decidedly stimulating effect upon the spinal cord, as well as the medulla and lower parts of the brain. Owing, it is believed, to its action on the cord, tetanic spasm is sometimes caused by large doses. In man it is much less constipating than morphine or opium, and in animals not infrequently has a purgative action. It has comparatively little effect in slowing the respiration, and, though the pupil is slightly contracted while the sleep it causes lasts, dilation is observed when the stage of excitement follows.

Therapeutics of Codeine.

In diabetes it is frequently used for reducing the amount of sugar in the urine, which it does more effectually than opium itself. For this purpose it is usually given as a pill or in a syrup. It is, as mentioned, very efficient in relieving cough of all kinds, and is an excellent substitute for morphine as an ingredient of expectorant mixtures. It is also very useful for allaying ovarian pain and as an analgesic generally, and is especially esteemed in cases where, as often happens in malignant disease, an anodyne effect is required to be maintained more or less continuously.

The other more important alkaloids of opium are the following:

Papaverine.—This is regarded as occupying a position midway between morphine and codeine as regards its action on the central nervous system, but it is very much less powerful than either. After large quantities some tetanic spasm may be produced by its action on the spinal cord, and, by a direct action on the cardiac muscle, the rhythm of the heart is slowed by it.

Anarcotine (known also as narcotine) is even less depressant than codeine, and reflex stimulation characterizes its action. It is an antiperiodic and valuable in the prevention as well as the treatment of malarial fever.

Thebaine (paramorphine), rather than a depressant, has a stimulating character, which appears to be identical with, though much feebler than that of strychnine. It has been found to increase peristalsis in the intestine.

HYDRATED CHLORAL.

CHLORALUM HYDRATUM.—Hydrated Chloral. **Dose, 1 gm. (15 gr.).**

ACTION OF HYDRATED CHLORAL.

External.—Like chloroform, hydrated chloral, commonly known as chloral, has marked **antiseptic** properties. Locally, it is irritant, and at the same time **anæsthetic.** Applied to the unbroken skin in concentrated solution it causes redness and sometimes vesication. On raw surfaces it has a decided corrosive action, and when injected subcutaneously is liable to excite considerable irritation.

Internal. *Alimentary Canal.*—Unless well diluted, it is irritant to the gastro-intestinal mucous membrane, and is therefore apt to occasion nausea, vomiting and purging.

Blood.—Chloral was first introduced as a hypnotic under the supposition that it was decomposed in the blood and chloroform liberated, but it is now known that it circulates unchanged, since no chloroform is found in the blood or expired air, and the drug itself is present in the urine both in a free state and in combination with glycuronic acid.

Circulation.—Large amounts, by **depressing** the **vaso-motor centre** in the medulla and by **direct action on the cardiac muscle,** have the effect of slowing and weakening the heart and of producing a fall of blood-pressure. It is thought probable also that the action of the drug on the muscular walls of the vessels has some influence in reducing the arterial tension. The same alterations in the heart's action are produced as by chloroform, the auricular contractions becoming weak before the ventricular, and some dilatation occurring in both cavities. In fatal poisoning the heart is arrested in diastole. In consequence of the vaso-motor paralysis, there results a marked dilatation of the cutaneous blood-vessels, and this may give rise to eruptions on the skin. Moderate doses usually have little effect on the pulse or blood-pressure, though these may possibly be transiently raised. Sometimes, however, even small amounts have a distinctly **depressing effect upon the heart.**

Respiration.—Under large doses the respiratory movements become more and more slow and shallow from the depressing action of the drug on the medullary centre, which may be aided by the extreme weakness of the heart. In fatal cases death usually occurs from **paralysis** of the **respiratory centre,** though sometimes, as in the case of chloroform, it is due to paralysis of the weakened heart. With moderate doses the respiration becomes slower and weaker, but scarcely more so than in natural sleep, in which the excitability of the respiratory centre and the volume of the inspired air appear to be very much the same as after small amounts of chloral.

Central Nervous System.—Chloral is the **purest hypnotic** we possess. It has the effect of depressing and eventually completely paralyzing the central nervous system. Under its influence there is a successive depression, first of the brain, then of the spinal cord, and finally of the medulla oblongata. With small doses, therefore, it is often possible to confine the action of the drug entirely to the cerebrum, with the result of producing a sleep closely resembling ordinary sleep. Under somewhat larger quantities the sleep is more profound, and there is a depression of the spinal reflexes, while under still larger amounts the depression extends to the medullary centres, which are finally paralyzed. Chloral differs from morphine in apparently having no specific action on the analgesic areas of the brain; so that acute pain is apt to prevent sleep after it. While a powerful hypnotic, it is not, therefore, an analgesic. It has also less influence on the sensibility of the skin than morphine, though very large doses cause anæsthesia. The **pupil** is always **contracted** under chloral. The irritability of the motor areas of the cerebral cortex is reduced by it, and they finally fail to respond to the strongest electrical stimulation. The spinal reflexes become paralyzed before the failure of the respiration. In the frog it has been observed that the depression of the reflex irritability may be preceded by a temporary increase, but this is believed to be probably due rather to the remote effects of the local irritation than to the direct action of the drug on the cord. Chloral appears to have no action on muscle or nerve when taken internally or injected into the circulation, but when applied to an exposed nerve it is found first to irritate and then paralyze it, and, when injected directly into the artery of a muscle, to produce immediate rigor. After the sleep caused by it the patient usually awakes refreshed, and free from headache or other disagreeable symptoms, though occasionally nausea and discomfort are felt.

Temperature.—Chloral causes a considerable reduction in the temperature, and this is largely due to the diminished heat production from the lessened muscular activity. Another factor, no doubt, is the increased output from the dilatation of the cutaneous vessels, and it is possible also that the irritability of the heat-regulating centres in the brain may be diminished.

Skin.—Chloral *habitués* often present peculiar purplish blotches upon the face.

Metabolism.—There appears to be an increased destruction of proteids, with a more or less incomplete oxidation of waste products. The acidity of the urine is found to be much increased by the presence of urochloralic acid (a combination of chloral and glycuronic acid), and the alterations in the me
olism are attributed to the excessive production of t
in the tissues. It is to be noted also that less ox
sorbed and less carbon dioxide given off in cons
lessened muscular movement.

Excretion.—It is excreted mainly by the kidneys as chloral and more largely as urochloralic acid. Part of it, however, is thrown into the stomach, and to this circumstance may possibly be due, it is thought, the gastric irritation which, as mentioned, is in some instances experienced on awaking from the sleep caused by chloral.

THERAPEUTICS OF HYDRATED CHLORAL.

External.—Chloral is used to some extent as a rubefacient and counter-irritant, as well as an antiseptic, but it is more expensive than many other equally effective remedies. As a wash or dressing for suppurating wounds, cancer of the uterus, foul ulcers, etc., it may be applied in a solution of 2 per cent. strength, and for bromidrosis or hyperidrosis in solutions of from 2 to 5 per cent. A 1 per cent. solution has been found efficient as an injection in gonorrhœa, and a 10 per cent. solution as an injection (into the sac) for hydrocele. The same may be injected into the neighborhood of varicose veins, with the effect of causing gradual coagulation of the blood and contraction of the vessels. The injection per rectum of from 1.60 gm. (25 gr.) of chloral, properly diluted, has been used as a remedy for hæmoptysis. The continued application of a solution of 1 in 4 each, of glycerin and water, has been recommended as a successful treatment for furuncle. Chloral solutions (about 5 per cent.) may be applied to parasitic skin diseases, such as tinea versicolor, and used to allay itching in eczema, prurigo, etc. The powdered drug incorporated in ointments is also of service in relieving the itching of cutaneous affections. In urticaria the following lotion has been employed: Chloral, 5; boric acid, 30; distilled water, 180 parts. In combination with other remedies it is used as a local anodyne and counter-irritant in neuralgia, pleurodynia, lumbago or other painful affections. An excellent preparation of this kind is composed of equal parts of chloral, camphor and menthol, rubbed up together to form a liquid. It may be applied to aching teeth and also to the larynx to relieve pain. It is also an effective preparation for rubbing into the legs to relieve painful cramps in the calves.

Internal.—Chloral has the advantages of being a promptly-acting and certain hypnotic. It is far from being a safe one, however; it depresses the heart and respiration so markedly that the prescriber should be always upon his guard. It does not relieve the distress and cough of disease of the heart and lungs, and must naturally be given, if at all, with special caution when these organs are affected. It had better be avoided for the most part, also, when stomach or bowel troubles are present, as it is very liable to increase the irritation of these parts. In the insomnia of fevers it is often of great service in the early stages, but as the disease progresses, the weakness of the heart may contra-indicate its use. As has been stated, it is of no value in producing sleep in cases in which insomnia is due to pain from any cause. It has been used as a cerebral depressant in puerperal convulsions, delirium tremens, and mania, but very large doses are usually required, and the effects of the drug must be watched with great care. Cases are recorded in which it has caused sudden death in alcoholics with fatty heart. In threatened delirium tremens, however, sleep may sometimes be induced by quite moderate doses in association with potassium or sodium bromide. It is of special value in sleeplessness from mental over-work, worry, etc., and in other forms of nervous insomnia. A very important use of chloral is in midwifery; here it has been designated the medicinal forceps. Frequently after rest has been obtained by this drug labor proceeds vigorously and is rapidly terminated. It has been employed with more or less success in incontinence of urine, tetanus, and poisoning by strychnine, physostigma and picrotoxin. If on account of spasm the patient is unable to swallow, it may be administered by the rectum. It is especially indicated in tetanus and strychnine poisoning because it depresses the motor tract of the spinal cord. It is a safer remedy for children than for adults, and is often prescribed for infantile convulsions, chorea, laryngismus stridulus, whooping-cough, and other spasmodic affections. It sometimes acts very happily in controlling or alleviating the paroxysms of whooping-cough. Chloral is of considerable value in seasickness, and may sometimes be efficacious in the morning sickness of pregnancy, especially in cases in which there is much dizziness, faintness, and repugnance to food, with but little vomiting. Should the odor of the drug tend to excite nausea, it may be given by the rectum. Administered in this way it has been advised for other forms of nausea and vomiting of reflex origin, such as occur in uterine fibroids and various other conditions. Notwithstanding the theoretical objections to the use of the drug in gastro-intestinal disorders, in severe cholera morbus, with symptoms of collapse, and in true cholera the hypodermatic injection of chloral is considered by some the most effective treatment that we have, and especially when morphine is employed with it. A favorite vehicle for the administration of chloral is syrup of tolu, and its unpleasant taste can be concealed by giving it in bottled "lemon soda."

TOXICOLOGY.

Acute Poisoning.—The symptoms of poisoning, as might naturally be supposed from the physiological action of the drug, closely resemble those of opium. Thus, there is profound coma, with weak and slow respiration and pulse and lividity of the surface. There is complete muscular relaxation, the reflexes are abolished, and the pupils contracted. The temperature is depressed, and the skin cold and clammy. The action of the heart is irregular as well as weak, and before death may become rapid. The pulse should always be carefully watched whenever chloral has been administered. It frequently happens that symptoms of failing heart come on unexpectedly even after small doses.

Treatment.—The stomach should be evacuated by the stomach tube. Emetics (*see* p. 159) may be employed, but are of less value on account of the depressing action of the drug on the medullary centres. Artificial warmth must be supplied by means of hot bottles and blankets, and the temperature maintained also by friction and massage. Somnolence is to be resisted by injecting strong coffee into the rectum and by such measures as flagellation, douches, flapping with wet towels, and shouting at the patient. On account of the cardiac depression, the patient should not be forced to take active exercise, such as brisk walking. The inhalation of amyl nitrite may be employed to stimulate the heart, and strychnine or caffeine subcutaneously injected to stimulate the respiration. Artificial respiration may also be called for.

Chronic Poisoning.—The chloral habit is very easily acquired by persons who have used the drug in ordinary doses for even a short time continuously for the relief of insomnia or other purpose, and, once established, it produces serious results and is very difficult to break up. The patient suffers from digestive disturbances, marked physical and mental weakness, with sudden flushings due to vaso-motor derangement, from palpitation of the heart, and from erythematous eruptions, generally of a purplish color, especially upon the face. In some instances there are bed-sores, ulcerations and sloughs. Dyspnœa, dependent upon the cardiac and respiratory depression and the general cachexia, is a prominent symptom. Sleep can be secured only by the accustomed hypnotic, and an over-dose may at any time result in collapse and death, since by reason of the cumulative effects of the poison in the system the vital functions are greatly impaired and elimination may be rendered impossible. It is to be noted also that the sudden withdrawal of the drug may lead to symptoms resembling those of delirium tremens, and as fatty degeneration of the heart is likely to be present, such a development is sometimes attended with the gravest danger.

CHLORALFORMAMIDE.

CHLORALFORMAMIDUM.—Chloralformamide. (Chloralamide.) **Dose, 1 gm. (15 gr.).**

Action of Chloralformamide.

This substance appears to have the cerebral action of chloral, without its depressing effects upon the circulation; the latter being counteracted by the stimulating influence of the formamide. In poisonous doses only does it produce any noteworthy depression. It is also less liable to produce gastric irritation than chloral, but would seem to be somewhat slower and less certain in its hypnotic effect. Chloral is formed by its decomposition in the body, and fatty degeneration is said to have been observed after its prolonged administration. Cutaneous eruptions are sometimes produced by it.

Therapeutics of Chloralformamide.

Chloralformamide may be employed in all cases in which chloral is indicated. It usually induces calm, refreshing sleep without any unpleasant after-effects, but in some instances causes confusion, dizziness and headache. It is gener
garded as of no more service than chloral in inso
pain, but some claim that it has a distinct anod
that it is useful in neuralgia and in the pai

It has been given with good results in some cases of nocturnal epilepsy and also in chorea. There seems to be no question that it is better borne than chloral when cardiac weakness is present, and it has sometimes been found to give relief in asthmatic symptoms due to heart trouble. If given for sleeplessness at night in the form of capsule or powder, it is advisable, on account of the slowness with which it is absorbed, that the dose should be administered rather early. Perhaps the best way to give it is dissolved in a little alcohol. 1.20 gm. (20 gr.), or more, may be dissolved in a sufficient quantity of brandy, and then water added at a temperature not above 54.4° C. (130° F.). It may also be administered very satisfactorily in a watery solution with syrup and a little dilute hydrochloric acid. 60 c.c. (10 ♏) of aromatic sulphuric acid added to 30 c.c. (1 fl. oz.) of water will generally dissolve 2 gm. (30 gr.) of chloralformamide, but not always, as some specimens of the drug are very insoluble. It may be given by the rectum as well as the mouth. Remarkable results have been obtained in seasickness from the use of chloralformamide in association with potassium bromide. In order to secure the best effect it is advised that the patient should take a cholagogue for two days before sailing. As soon as he gets on board the ship he should take 2 gm. (30 gr.) of each drug on an empty stomach, and at once go to bed and sleep. This combination may be of service in acute mania and other forms of insanity. In using chloralformamide continuously it is not necessary to increase the dose, and with it there appears to be less danger of the patient's becoming an *habitué* of the drug than in the case of chloral.

Chloretonum.—Chloretone (unofficial). (Chlorbutanol. Trichlor-tertiary-butyl Alcohol. Acetone Chloroform.) **Dose, 0.30 to 1.20 gm.; 5 to 20 gr.**

ACTION OF CHLORETONE.

Without markedly influencing respiration or blood-pressure, it produces sleep. The hypnotic effect is obtained by the use of smaller amounts than are required in the case of hydrated chloral. It directly affects sensory nerves, and so may be used as a local anæsthetic. After excessive doses of it dogs may sleep for several days, finally succumbing from asphyxia. Since neither acetone nor chloroform are found in the expired air or the urine, and the chlorides are increased in the latter, it is probably broken up in the body.

THERAPEUTICS OF CHLORETONE.

In one per cent. solution it may be applied as a local anæsthetic to ulcers and infected wounds. Internally, its chief use is as a hypnotic which is both safe and generally efficient. In moderate doses it promptly relieves irritability of the stomach.

SULPHONMETHANE.

SULPHONMETHANUM. — Sulphonmethane. (Diethylsulphonedimethylmethane. Sulphonal.) **Dose, 1 gm.; 15 gr.**

ACTION OF SULPHONMETHANE.

Sulphonmethane, while a less efficient hypnotic than hydrated chloral, is also less dangerous, as it has no depressing cardiac action. It does not affect the heart directly, though it may cause a slight quickening of the pulse through its depressant effect upon the inhibitory centre. Through its action on the central nervous system it also has some influence in diminishing metabolism. Its excretion appears to be slower than its absorption, so that there is a tendency to a cumulative action. This may lead to gastritis, renal disease, and certain changes in the blood which are not very clearly understood. In consequence of the latter there is a characteristic discoloration of the urine, due to the presence in it of a reddish-brown pigment, hæmatoporphyrin, which is an iron-free product of the decomposition of hæmatoglobin. This is found to occur chiefly in anæmic women, and is accompanied by constipation, vomiting and gastric pain, weakness and ataxia, confusion and partial paralysis, while eventually there may result suppression of the urine or collapse and death. Several fatal cases of poisoning by this drug have been reported from small doses continued long periods. Sulphonal does not often lead to a habit cases of this are sometimes met with. Though its co use may not induce the very grave results mentioned, it may be attended by severe functional disturbances. Persons taking it regularly for a considerable time are liable to suffer from mental, moral and muscular weakness, indigestion, impaired nutrition, and persistent cutaneous eruptions. The untoward effects of the drug can usually be avoided by intermitting its administration from time to time. It is thought to have some deleterious action on the heart when used for long periods, and is found to be a much less certain hypnotic in cases of cardiac disease than in other conditions. Very large quantities of sulphonal have been taken without fatal results, and in fact without any more serious consequences than prolonged unconsciousness. An enormous single dose, however, has been known to cause paralysis of the sphincters, anuria, a fall of temperature, and, late in the case, depression of respiration. Very large amounts are said to produce convulsive movements in animals. The drug is largely decomposed in the body, and excreted in the urine as ethylsulphonic acid, but a small portion escapes unchanged. Sulphonal has little or no effect in relieving pain. As its absorption is very slow on account of its insolubility, sleep is somewhat late in following its administration, and not infrequently more or less drowsiness and depression are experienced the next day.

THERAPEUTICS OF SULPHONMETHANE.

Sulphonal is used exclusively to produce sleep. It is preferably administered in hot water, but on account of their convenient form, it is often given in wafers or tablets. These should be taken at least an hour and a half before the time when sleep is desired.

SULPHONETHYLMETHANE.

SULPHONETHYLMETHANUM.—Sulphonethylmethane. (Diethyl sulphonmethylethylmethane. Trional.) **Dose, 1 gm.; 15 gr.**

ACTION OF SULPHONETHYLMETHANE.

Sulphonethylmethane is a prompt hypnotic, without marked cumulative action, and it has no injurious or unpleasant after-effects. Apparently the patients do not become habituated to its use.

THERAPEUTICS OF SULPHONETHYLMETHANE.

As it is more soluble, quickly absorbed and active, trional is generally preferred to sulphonal. It has been used as a hypnotic and sedative for the insane; for narcotic *habitués*, so far as is known, it is a safe remedy. It is important that the daily action of the bowels be secured, an alkaline water be given daily, and weekly intermissions be insisted upon; otherwise it may give rise to disagreeable after-effects. It rarely produces hæmatoporphyrinuria. As is also the case with sulphonal, multiple neuritis may follow the prolonged administration of small doses of trional.

VERONAL.

Veronalum.—Veronal (unofficial). (Diethylmalonylurea.)
Dose, 0.5 to 1.5 gm.; 7½ to 22½ gr. in hot liquids.

ACTION OF VERONAL.

External.—None.

Internal.—It does not usually cause nausea, vomiting or any gastric disturbance. It probably has no effect upon the blood, for no blood pigments appear in the urine. It does not influence arterial tension, nor does it have any effect upon the pulse rate nor upon respiration. A slight antipyrine-like rash, has been observed in a few instances, accompanied by itching. The temperature is slightly lowered two or three hours after a moderate dose has been taken. Sleep generally ensues within an hour after the injection of the drug and is likely to last from four to ten hours. The awakening may be accompanied by some torpor. There is a possible analgesic action upon the spinal cord.

Excretion.—The urine usually remains normal, free from albumin, sugar, and blood pigment. In some instances the drug causes hæmatoporphyrinuria. The nitrogen excretion is diminished.

THERAPEUTICS OF VERONAL.

The remedy is useful in the treatment of insomnia of varied causation. It is especially useful in the simple insomnia and sleeplessness of neurasthenic or hysterical origin. In conditions of excitement the maximum dose should be employed. Since it is without action upon the circulation or respiration it may be administered to patients suffering from cardiac or pulmonary diseases. As it does not increase the nitrogenous output of the kidneys it can be safely given to debilitated individuals, and for considerable periods of time, as well as in febrile conditions and wasting disorders. As it is fairly safe for continued use, reasonably sure in its results, possesses comparative freedom from habituation, and produces a sleep approaching the normal, it is a valuable addition to the available hypnotics. The perspiration of pulmonary tuberculosis, it may be noted, is sometimes diminished by evening doses of the drug.

Untoward Symptoms.—These occur infrequently and are the exanthem already mentioned, loss of appetite, nausea, vomiting, diarrhœa, headache, vertigo, and rarely torpor lasting through the following day. Cumulation is not to be anticipated.

TOXICOLOGY.

Symptoms.—In a single instance there have been observed febrile reaction for about a week, dryness of the mouth, burning sensation in the throat, a morbilliform exanthem on the face, extending to the chest and arms, becoming confluent, followed by a vesicular and bullous eruption upon the buccal and pharyngeal mucous membranes, conjunctivitis, and pain in the ears. Hæmatoporphyrinuria is occasionally met with.

Treatment.—Interruption of the treatment, or alternation with hypnotics of other series, administration of the alkaline mineral waters, with the securing of a daily movement of the bowels, will obviate these symptoms.

PARALDEHYDE.

PARALDEHYDUM.—Paraldehyde. **Dose, 2 c.c. (30 ♏).**

ACTION OF PARALDEHYDE.

External.—It is antiseptic and antifermentative.

Internal.—Paraldehyde is a prompt, powerful and safe **hypnotic.** The system is usually very tolerant of it, and it may be continued and found useful for long periods. In animals, in which it acts in the same manner as upon man, it depresses the higher nervous centres first; later it diminishes the reflexes, and finally there is a marked effect on the spinal cord. The anterior cornua are paralyzed, and there are abolition of reflex action, paralysis and anæsthesia. Fatal results from it are rare, but enormous quantities may cause death by paralyzing the respiratory centre in the medulla. Its action on the heart is similar to that of sulphonal, causing a slight acceleration of the pulse by its depressant effect upon the inhibitory centre. It often produces gastric irritation and an increased flow of urine. It is chiefly excreted by the kidneys, but in part also by the lungs, and the odor of the drug may be detected in the breath for some time after its hypnotic effect has passed off. An erythematous rash is sometimes caused, and its prolonged use is said to have induced gastric catarrh and ulcers about the nose. Diarrhœa has also been observed. Instances of the paraldehyde habit have been occasionally reported. There is great emaciation, cardiac weakness, unsteady gait, and mental confusion and agitation, with hallucinations of sight and hearing and unpleasant delusions. Restraint for several months is necessary for cure.

THERAPEUTICS OF PARALDEHYDE.

Unlike hydrated chloral, paraldehyde may be given with safety in cases of cardiac disease. The principal objection to the drug is its disagreeable and burning taste, and hence it is usually administered in capsules. If not given in this way, syrup and tincture of orange peel (with at least 60 c.c.; 2 fl. oz. of water, so as to insure the dissolving of the paraldehyde) may be employed to conceal the taste, or the drug may be administered in glycerin, in a 25 per cent. solution, which renders it more palatable. The large dose required is also a disadvantage. If paraldehyde is to be of service, it usually produces sleep in from fifteen to thirty minutes, and this is placid, dreamless and refreshing. No lassitude or depression is experienced the following day, and the appetite often improves under its use. It is useful in most cases of simple sleeplessness, but is found to be of little service if there is any pain, or if there is cause for worry and anxiety. To patients with gastric irritability and in cases where there are convulsions it may be given by the rectum. Paraldehyde is principally used in institutions for the insane. It has been found valuable in all forms of mania, including the delirious mania due to alcohol or epilepsy. In cases of melancholia it may induce sleep, but is often disappointing. It is useful in mental excitement associated with chorea, and in many cases of senile excitement, with marked restlessness, it has been pronounced the best remedy. It has a certain value in convulsive diseases, and has proved of service in some cases of epilepsy, chorea and strychnine poisoning. It sometimes relieves the symptom asthma and the paroxysms of whooping-cough, but on account of its disagreeable taste and pungent odor it is not well suited for children. It is said to have been efficacious in some cases of polyuria.

ETHYL CARBAMATE.

ÆTHYLIS CARBAMAS.—Ethyl Carbamate. (Urethane. Ethyl Urethane.) **Dose, 1 gm. (15 gr.).**

ACTION OF ETHYL CARBAMATE.

Urethane is a hypnotic, and is believed to induce a calm, natural sleep without any disagreeable after-effects.

THERAPEUTICS OF ETHYL CARBAMATE.

It was employed more frequently formerly than at present, as it so often proves disappointing. In some instances it appears to act as an almost ideal hypnotic, but, unfortunately, there are many cases in which it has no effect. It is most successful in those in which there is no pain and where the sleep is wanting rather from habit than from any uneasy feeling or from worry. It has been found beneficial in children and in some cases of sleeplessness following fevers or the result of alcoholic excess; also in some instances where other more powerful drugs, such as hydrated chloral, have been taken for some time and where the patient feels that he must have sedatives to help him to sleep. It does not appear to be of much service among the insane.

HOPS.

HUMULUS.—Hops. **Dose, 2 gm. (30 gr.).**

LUPULINUM.—Lupulin. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Fluidextractum Lupulini.**—Fluidextract of Lupulin. **Dose, 0.5 c.c. (8 ♏).**
2. **Oleoresina Lupulini.**—Oleoresin of Lupulin. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

ACTION OF HOPS.

Like other substances containing volatile oils, hops, to a slight extent, reflexly excite the circulation, and are stomachic and carminative. The bitter principle likewise adds to the stomachic properties of the drug. Hops have an undoubted sedative and hypnotic influence, but it is not very marked, and appears to be subject to considerable variation.

THERAPEUTICS OF HOPS.

Hops are used medicinally chiefly in the form of bitter ale, which derives from them its peculiar flavor and taste, as well as a certain degree of its heavy, soporific effect. Ale, stout, or good beer may sometimes serve to improve the appetite and digestion and to secure sleep, and such effects are naturally increased by the alcohol contained in them. Hops may sometimes be employed with advantage in atonic dyspepsia, flatulent colic, and mild diarrhœas. Lupulin has been used in nervous tremors, wakefulness and the delirium of drunkards. Equal parts of fluidextract of lupulin and tincture of capsicum constitute an excellent substitute for alcoholic stimulants when it is desired to break off the use of the latter, and this combination is also very useful for the wakefulness and excitement preceding a threatened attack of delirium tremens. Lupulin, as the oleoresin, is supposed to have some value as an anaphrodisiac, and it is sometimes of service in spermatorrhœa. A hop pillow often seems to have a soothing and soporific influence, but this result is doubtless to a great extent the effect of imagination and the association of ideas. So, also, hop poultices are used for their alleged anodyne action, but any benefit derived from them is to be attributed simply to the heat and moisture.

LACTUCARIUM.

LACTUCARIUM.—Lactucarium. (Lettuce.) **Dose, 1 gm. (15 gr.).**

Preparations.

1. **Syrupus Lactucarii.**—Syrup of Lactucarium. **Dose, 8 c.c. (2 fl. dr.).**
2. **Tinctura Lactucarii.**—Tincture of Lactucarium. **Dose, 2 c.c. (30 ♏).**

ACTION OF LACTUCARIUM.

Lactucarium has been credited with mild hypnotic powers. Fresh lettuce is said to contain traces of hyoscyamine, and since classic times has been known as tending to induce slumber. Large doses of the green extract may cause mental derangement, and will dilate the pupil.

THERAPEUTICS OF LACTUCARIUM.

It is quite unreliable as a hypnotic, but in some instances appears to have a quieting and soporific effect. It may be tried as a substitute for opium and its alkaloids when these disagree. The syrup is sometimes added to cough mixtures as a sedative, especially for children, and has also been employed to allay nervous irritability and as a substitute for the soothing syrups containing opium.

METHYLENE BLUE.

METHYLTHIONINÆ HYDROCHLORIDUM. — Methylthionine Hydrochloride. Methylene Blue. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF METHYLENE BLUE.

Methylene blue (not to be confounded with methyl blue) has been introduced into medicine as an antiseptic. It also possesses anodyne and diuretic properties. It imparts a blue color to nerve substance and a like color to the urine.

THERAPEUTICS OF METHYLENE BLUE.

It has been used for rheumatism of the joints and muscles, migraine, sciatica and other neuralgias; also for alcoholic neuritis and the pains of locomotor ataxia. It would seem to be a remedy of some value for quieting patients suffering from incurable mental disease in which excitement is a prominent symptom. In a number of cases of mania and paretic dementia it produced a calmative effect which did not resemble the action of hypnotic drugs, but seemed rather a natural quietude. Lately it has been given for intermittent fevers, but the reports show that it possesses no advantage over quinine except its tastelessness. It may be substituted for quinine if the latter cannot be taken or has been unsuccessfully used. Recent reports indicate that even when given internally, it causes gonococci to rapidly disappear from the urine in specific urethritis. As to its effects upon inoperable neoplasms when injected into them clinical reports differ widely. It may produce irritation at the neck of the bladder, which about 2 gm. (30 gr.) of powdered nutmeg is said to relieve.

(3) General Anæsthetics.

CHLOROFORM.

CHLOROFORMUM.—Chloroform. (Trichloromethane.) **Dose, 0.3** c.c. (5 ♏).

Preparations.

1. **Aqua Chloroformi.**—Chloroform Water. **Dose, 16 c.c. (4 fl. dr.).**
2. **Emulsum Chloroformi.**—Emulsion of Chloroform. **Dose, 8 c.c. (2 fl. dr.).**
3. **Linimentum Chloroformi.**—Chloroform Liniment.
4. **Spiritus Chloroformi.**—Spirit of Chloroform. (Chloric Ether.) **Dose, 2 c.c. (30 ♏).**

ACTION OF CHLOROFORM.

External.—The local action of chloroform quite resembles that of alcohol, but is more energetic. It is also more powerfully **antiseptic.** Chloroform is a protoplasmic poison of great intensity, and no living substance is capable of withstanding its lethal effect if exposed to its concentrated vapor for a sufficient time. Its evaporation on the skin has a **refrigerant** effect, and hence causes contraction of the blood-vessels and **anæsthesia** at the point of application. If, however, the vapor is confined, or if chloroform is rubbed into the skin, it has the effect of causing heat and redness, with dilatation of the local vessels; and the irritation may be sufficient to produce **vesication.** While when locally applied it is more irritant to mucous membranes than ether, yet when inhaled it is less irritant than the latter to the respiratory tract.

Internal. *Alimentary Tract.*—In the mouth it causes, in concentrated form, a burning sensation and pain, followed by anæsthesia, and increased secretion of saliva and mucus by reflex excitation of the glands. In the stomach and intestine it is also markedly **irritant,** often causing violent gastro-enteritis. In small doses its action is very much like that of the volatile oils, producing in the stomach a sense of warmth and comfort and inducing increased peristalsis. Absorption, it is believed, takes place more rapidly than in the case of the volatile oils. In the intestine it may perhaps have a slightly astringent effect.

Blood.—Chloroform is absorbed into the blood from the gastro-intestinal tract, and, if administered by inhalation, from the lungs, and after absorption is thought to form a loose combination with the cholesterin and lecithin in the blood, perhaps in the red corpuscles.

Nervous System.—The effects of the drug, when inhaled, are commonly divided into three stages. It must be borne in mind, however, that there are no sharply defined dividing lines between them, and that they are simply different degrees of the same action. For convenience of study they may be named the stimulant, the anæsthetic, and the paralytic.

First Stage.—There is a more or less marked preliminary feeling of asphyxia, but with this exception, the sensations are rather pleasant than otherwise. There is a sense of warmth experienced first about the face and head, but afterwards extending throughout the body, while the imagination is temporarily excited. The patient's comfort, however, may be disturbed by the local effects, such as pricking and smarting of the nose, throat and conjunctiva, accompanied by increased secretion of saliva, mucus and tears. Vomiting may possibly occur, but is rare at this period. The mind becomes confused from the irregular stimulation of the higher cerebral functions, but this stimulation is only evanescent, and the patient soon begins to lose consciousness. Hallucinations are apt to be present, and the special senses are disturbed, so that he experiences unusual sensations of light, and ringing, hissing and roaring in the ears. There is formication and a feeling of stiffness in the muscles and of inability to move the limbs. He loses his self-control, and gives way to manifestations which vary with his character—loud talking, laughing, singing, weeping, swearing, etc. The general sensibility becomes blunted, but is not abolished. With the depression of the higher functions comes on excitation of the lower motor functions, and the patient now often begins to struggle violently. He will kick, fight and throw his arms and legs about to such an extent that it is difficult to restrain him. These motor phenomena vary greatly in different individuals, and in some instances, especially in children, are entirely absent. Occasionally, and particularly in hysterical subjects, convulsions are observed. In this stage usually the pupils are somewhat dilated, the skin warm and moist, the face flushed or cyanotic, the pulse accelerated, and the apex-beat augmented. The respiration is generally slightly quickened, but may be more or less irregular, at first in consequence of the sensation of asphyxia and later from the struggling.

Second Stage.—The inhalation being maintained, the movements cease and the muscles become relaxed. In consequence of this relaxation, the face, which is now pale, assumes a calm and death-like appearance. The smooth muscles are not usually affected, but there is sometimes a relaxation of the sphincters. There is paralysis of the motor reflex centres of the cord, as well as paralysis of the brain and depression of the medullary centres. Consciousness, sensation and most reflexes are abolished, and one of the last reflexes to disappear is the corneal. The pupils are contracted and do not respond to light, and the patient lies in a deep sleep. Snoring is apt to be produced from the falling back of the tongue. The respiration becomes regular, but slower and shallower than before the inhalation was commenced. The pulse is generally somewhat slow and weak, but regular, and the blood-pressure falls on account of the depression of the vaso-motor centre. Vomiting is a frequent occurrence, and dilatation of the pupil and increased pallor are generally indications of its approach. The body temperature invariably sinks in consequence of the lessened muscular activity and to a less extent of the increased heat loss, and in prolonged anæsthesia the fall may be as much as 3° to 5° C. When the inhalation is discontinued, the patient again passes through a stage of excitement, which is generally much less violent but may be more prolonged than before. Usually in recovering from the anæsthesia he falls into a sleep which lasts several hours, but not infrequently there are dizziness, nausea and vomiting for a considerable time.

Third Stage.—The characteristic feature of this stage, which must be carefully guarded against, is progressive paralysis of the medulla. The surface is cold and covered with a clammy sweat, and the pupils become widely dilated, though at the last they may be either dilated or contracted. The fæces and urine are often passed involuntarily. The respiration grows irregular, stertorous and labored. The pulse, now also irregular, becomes more and more slow and feeble, the blood-pressure falls to zero, and the heart, weakened and dilated, is finally arrested in diastole.

There has been much discussion as to the cause of death in chloroform anæsthesia, and in 1889 the Nizam of Hyderabad appointed a special commission to investigate the question. After experimenting on over six hundred animals the commission arrived at the conclusion that death is always due to arrest of the respiration. The criticism has been made that the alterations in the circulation produced by chloroform were not properly appreciated by these investigators, or, at all events, were not sufficiently emphasized in their report, and in the United States it has generally been believed that death is from depression of the heart. It may be stated that it is now generally accepted that the fatal effect of chloroform, as seen in its use as an anæsthetic in surgery, is due chiefly and in most instances to its action upon the circulatory system, and especially upon the heart itself. There seems to be no doubt of the fact that in general the mode of administration really determines the manner of its lethal action. Thus, a percentage of chloroform vapor so low as to be practically incapable of causing sudden death will, if the administration is maintained, finally bring about a fatal result from over-narcosis, and under these circumstances it is almost invariably the case that death is due to failure of the respiration from paralysis of the respiratory centre in the medulla. Experiment has demonstrated that under the inhalation of very dilute chloroform the respiration always ceases several minutes before the heart, which continues to beat quite strongly for a short time and then grows rapidly weaker, and that as the concentration of the vapor is increased, the interval between the failure of the respiration and of the heart becomes shorter. When air saturated with chloroform vapor is inhaled, the interval between the two is so brief as to be inappreciable. The pulse, indeed, may be so weak as to be no longer perceptible before the respiration ceases, but if the movements of the heart be registered directly, it is usually found beating as long as the respiratory movements are carried on. From a practical point of view, it has been pointed out, it is of comparatively little importance whether there are a few fluttering beats of the heart after the last inspiration or not; the all-important question is whether the heart has been so injured as to be unable to carry on the circulation. Clinical experience has shown that it is the sudden administration of a high percentage of chloroform vapor which is responsible for most of the fatalities from this drug, and it is through its direct action on the heart that death is then caused. The cardiac muscle becomes paralyzed and more or less suddenly fails to be effective in maintaining the circulation, so that the blood-pressure falls rapidly. The heart is now incapable of emptying itself, and, the organ becoming distended with blood, its muscle, after a few slight fibrillar contractions, confined to the ventricular bases, finally stops acting. In some instances in dogs, however, the heart has been found flabby and empty. The action of the respiratory system during this time must be regarded as for the most part secondary to the state of the circulation. When the blood-pressure has fallen considerably, the medullary centres become anæmic and the respiration fails. When the respiratory movements cease, the lesser, or pulmonic, circulation fails in consequence, and this embarrasses the heart still further, precipitating its distention and complete paralysis. Not only is the heart in a condition of paralytic distention, but the great vessels of the chest and abdomen are also distended with blood. In fact, the vaso-motor paralysis of the vessels in the splanchnic system must always be taken into consideration in determining the factors which bring about a fatal issue.

In its action on the central nervous system, as has been seen, chloroform affords an excellent illustration of the law of dissolution (*see* p. 639). Thus, the paralysis caused by it commences with the highest cerebral functions, those of self-control, and passes progressively downwards through the lower intra-cranial divisions. The spinal cord is affected before the medullary centres, which are the last portions of the cerebro-spinal axis to become paralyzed. In the recovery from chloroform also the law of dissolution is illustrated, the lowest functions, such as muscular tone, being the first to reappear. The muscles and nerves are not affected by chloroform when inhaled.

Metabolism.—A marked resemblance has been noted between the effects of chloroform on the metabolism and those of phosphorus, and in both cases the formation of acid in excess in the tissues has been assigned as the cause of these effects. After the administration of chloroform, either by inhalation or by the mouth, both nitrogen and sulphur elimination is considerably augmented; indicating, it is believed, an increased destruction of nitrogenous bodies in the tissues. The sugar of the blood has been found to be increased, and the glycogen of the liver diminished, or entirely absent. This is stated to be due to a specific action on the liver cells, which form glycogen into sugar much more rapidly than usual. Fatty degeneration of various organs, especially the liver, heart and kidneys, has been observed after the repeated administration of chloroform, and even after a single inhalation in some instances. If this process attains a certain degree of development it is found that it may lead to failure of the heart, but otherwise the tissues recover in a few days. Atrophic cirrhosis of the liver has been produced by the drug when given in small quantities for several months. Similar but less marked effects have been observed in the kidneys, spleen and lungs, and they are regarded as the result of a preliminary fatty degeneration of the parenchymatous cells. In addition to its action on the central nervous system, it must therefore be recognized that chloroform produces marked changes in the processes of life and the nutrition of the different organs.

Excretion.—Chloroform is excreted mainly by the lungs, but in small quantities may also escape in the urine, perspiration and milk. Some of the chloroform inhaled seems to undergo combustion in the body, and an increased acidity of the urine is attributed to hydrochloric acid formed by the combustion.

THERAPEUTICS OF CHLOROFORM.

External.—The local application of chloroform has been found useful in a variety of conditions. In severe neuralgias its deep injection in the vicinity of the affected nerve is a valuable resource. The official liniment is employed to relieve the pain of neuralgia, myalgia and chronic rheumatism and to reduce chronic inflammations. Chloroform is also often used in liniments in association with camphor, tincture of aconite, or opium preparations. The following is highly recommended as a local anæsthetic: Chloroform, 6; camphor, 1; tincture of aconite, 6; tincture of capsicum, 2; tincture of pyrethrum, oil of cloves, each 1. The camphor is first dissolved in the chloroform, and the oil of cloves and the tinctures are then added. For overcoming rigidity of the perineum in labor the following application has been found useful: Chloroform, 1; ether, 1; Cologne water, 8. The following combination has been recommended as an efficient anæsthetic spray for the performance of minor surgical operations: Chloroform, 37; menthol, 4; ether, 56. An aching tooth may often be relieved by plugging it with cotton saturated with chloroform. Chloroform is a good hæmostatic, and applied upon lint or absorbent cotton, may be used to arrest superficial bleeding. The solution of gutta percha in chloroform has been employed as a protective in small-pox and erysipelas, and has also been found useful in the treatment of fissured nipple, superficial burns, furuncles, psoriasis and herpes zoster. A lotion containing chloroform may be of service in urticaria. In irritable ulcer of the rectum and itching about the anus an ointment, such as that of zinc oxide, to which chloroform has been added in the proportion of 1 to 8, often affords great relief. Chloroform is an excellent antiseptic to preserve urine in transportation. .20 c.c. (3 ♏) to 120 c.c. (4 fl. oz.) of urine is sufficient. The chloroform should be allowed to evaporate before testing the urine.

Internal.—As chloroform disguises the taste of many nauseous drugs, it is in common use for this purpose. Aqua Chloroformi is frequently employed as a vehicle and Spiritus Chloroformi as a flavoring agent. Like alcohol, the gastric effects of which are similar, chloroform is useful in some forms of dyspepsia, and in small doses it is sometimes given as a cardiac stimulant. Chloroform water, or a few drops of chloroform taken upon sugar or in water, will often relieve vomiting when not due to inflammations of the stomach. Small doses of it, however, may prove of service for the vomiting and pain of gastric ulcer, especially when given in association with bismuth preparations. The spirit of chloroform is used to arrest hiccough and also to relieve restlessness and irritating cough in pneumonia, pleurisy and bronchitis. A small quantity of it is a serviceable addition to expectorant mixtures when a neurotic element is present. 2 c.c. (½ fl. dr.), with an equal quantity of tincture of capsicum, in water, every half hour, hour, or two hours, has proved a valuable hypnotic in delirium tremens with symptoms of depression and adynamia. The spirit of chloroform is sometimes given also with advantage, in combination with astringents and opium, in diarrhœa, and is considered especially useful in cholera morbus. The following, taken as a draught, is said to be successful in the treatment of tape-worm: Chloroform, 4 c.c. (1 fl. dr.); croton oil, .06 c.c. (1 ♏); glycerin, 30 c.c. (1 fl. oz.). Somnolence, so prolonged as to become serious, may, however, follow the administration of this prescription.

Inhalation.—The inhalation of chloroform for anæsthetic purposes is principally employed for surgical operations, in biliary and renal colic, and in parturition. For painful delivery but a small quantity is required, as it is given, not to produce unconsciousness, but merely to blunt the sensibility, and it is a matter of common observation that chloroform inhalation is borne better by women in labor than by any other class of subjects. Other purposes for which its inhalation is used are the relaxation of muscular spasm, as for the reduction of dislocations and herniæ, and to relax the muscles for diagnostic reasons, as for making a thorough examination of fractures or of the abdomen, for the detection of malingering, etc. Finally, it is used for the relaxation of spasm in the convulsions of tetanus, hydrophobia and other affections. In certain anæsthetic mixtures, which contain both ether and chloroform, the object is to obtain the anæsthetic effects of both these agents without the cardiac and respiratory depression of either. The best known of these is the A. C. E., which consists of 1 part alcohol (sp. gr. .838), 2 parts of chloroform (sp. gr. 1.497), and 3 parts of ether (sp. gr. .735). It is claimed that all of its three constituents volatilize from it at an equal rate, but as this has been found not to be the case (the ether evaporating first, the chloroform next, and the alcohol last), the advantages of the mixture would seem to be doubtful. While the A. C. E. enjoys considerable popularity in England, it has never been much liked in the United States.

In the administration of chloroform careful attention must be paid to the following:

1. The anæsthetizer must be skilled, and give his attention exclusively to the production and maintenance of narcosis.

2. False teeth should be removed from the patient's mouth, to prevent the possibility of their falling into the throat and choking him.

3. No undigested food should be in the stomach; the patient

should be fasting for at least four hours, if possible. If vomiting occurs, his head should be placed in such a position that no food can get into the larynx.

4. The clothing must be loose enough to allow perfect freedom of respiration.

5. The head should be a little raised and the lower jaw held up, in order to prevent the tongue from falling back over the larynx.

6. The chloroform must be pure.

7. It should be given in such a way that the vapor may be thoroughly mixed with air in the proportion of about 5 to 95.

8. The administration must be gradual, as "pushing" the anæsthetic is dangerous.

9. The respiration should be watched with extreme care, as it appears to be a fact that gradual cardiac failure never takes place without producing respiratory changes from the first. A sudden cardiac arrest, as sometimes occurs in fatty heart, will not give warning either by the pulse or respiration.

10. The operation should never be commenced until the stage of muscular relaxation has set in, when reflex action is to a large extent abolished. From neglect of this precaution many lives have been lost, the heart being reflexly stopped by the stimulus of the knife; and it is a fact that most of the deaths from chloroform have occurred during slight operations, in consequence of the mistaken notion that because an operation is trivial it may be begun early.

11. In operations about the mouth care must be taken to prevent the entrance of blood into the air-passages.

12. The anæsthetic must be administered with special care in the old and in all cases where pulmonary disease is present or where the heart is feeble from any cause. It is contra-indicated in fatty heart.

13. Special care is also called for when the operation necessitates awkward positions, and particularly those (such as the lateral position) in which the respiration is more or less interfered with.

14. In consequence of the reduction of temperature caused by chloroform, the warmth of the patient must be attended to.

15. Chloroform should never be administered without a hypodermatic syringe, in good order, being at hand. Amyl nitrite, ether and ammonia should be in readiness.

16. Inasmuch as substances irritating to the lungs may be produced when the vapor of chloroform comes in contact with a naked flame (in the presence of which chloroform is decomposed), good ventilation should be insisted upon when gas light must be employed.

Should any signs of respiratory failure occur, artificial respiration must at once be commenced, the tongue being pulled forward by forceps to facilitate the ingress of air. The most efficient means of performing artificial respiration is the use of the Hoyt pump, each full stroke of the piston of which forces into the lungs, through an intubation tube inserted in the larynx, an amount of air corresponding with the normal inspiration. Other measures which may be employed are the flicking of the face and abdomen with wet towels, the administration of amyl nitrite by inhalation, and the hypodermatic injection of strychnine or ether. Brandy, or alcohol in other form, should not be given. Galvanization over the cardiac area has been recommended, but it is probable that this is harmful rather than beneficial. The heart may be stimulated by large rectal injections of hot normal saline solution, or of hot decoction of coffee, if at hand. One of the most efficient means of maintaining or restoring the action of the heart and the respiration is the Maas process. This consists of the application of a series of compressions of the chest over the heart sufficiently forcible to create an artificial carotid pulse, the compressions being made at the rate of 120 per minute. The object in view is to create an artificial circulation which may free the heart from distention and chloroformed blood, and raise the arterial tension so that the respiratory centre may be supplied with blood. If symptoms of improvement do not appear at once, the patient should be inverted, and this procedure is facilitated by hooking the knees over the table. It is claimed by some that inversion only adds to the danger, but there is a vast amount of clinical evidence going to show that it is of practical benefit, numerous instances being on record in which it was undoubtedly the means of saving the patient's life. The measures just mentioned should be maintained for hours, if necessary; but if in spite of them the heart utterly ceases to pulsate and the respiration completely fails, as a last resort the chest should be opened and cardiac massage practiced by the Kemp-Gardner method, artificial respiration at the same time being maintained and the prolonged infusion of hot normal saline solution employed.

Chloroform may be chosen in hot climates; when a large number of persons are to be anæsthetized; in Bright's disease; in aneurism; in marked atheroma of blood-vessels; in children or adults who already have bronchitis; and in persons who struggle violently.

In 1901 a special committee was appointed by the British Medical Association to investigate chloroform in its therapeutic uses, the ultimate aim of the research being to determine the minimum dose of chloroform capable of producing adequate anæsthesia without endangering life. The first report of the committee was made in the summer of 1902 and the final report in that of 1903. In regard to the point whether the ordinary methods of administering chloroform are trustworthy and safe, the conclusion was reached that it is absolutely necessary to regulate the dosage of the drug, and that an apparatus is eminently desirable which will on the one hand permit the administration of a definite dose capable of securing anæsthesia and on the other not endanger life. Furthermore, that safety depends upon dosage, that is, the proper percentage to be mixed with air. Concentration has been shown to be fatal, whereas it is maintained that a vapor below 2 per cent. is wholly safe, and that in most patients as low as 1 per cent. will maintain anæsthesia. A further step was to determine with scientific accuracy what the physical effects of various percentages were. Working with the isolated mammalian heart, the investigators found, among other points, that heart muscle takes up chloroform from fluid circulating in the coronary vessels and that its lethal effects vary according to the fluid used. In diluted blood, for example, the chloroform gives less effect than in saline solution. With the increase of chloroform in the circulating fluid, more is taken up by the heart muscle, until finally toxic effects result. With weaker doses an equilibrium appears to be established between the chloroform-containing fluid and the heart muscle, so that at last no further effect upon the muscle manifests itself, in spite of the continued flow of the chloroform fluid. It was found that under toxic doses the ventricle is paralyzed in its action before the auricle. The experiments go to show the extreme importance of restricting the dosage of chloroform to relatively weak percentages, and that the size of the dose circulating in fluid through the heart is the important element, rather than the length of time during which it circulates. Higher concentrations than 2 per cent. should be looked upon as potentially dangerous, since their tendency is, other things being equal, to paralyze the heart muscle. The prolongation of the anæsthesia with a dilution under this percentage is not to be regarded as dangerous, although naturally individual susceptibility must be taken into account, and, as usual, arguments drawn from animals cannot be forthwith and without modification applied to man. It will be observed that these experiments in a measure controvert the idea that chloroform has a cumulative effect upon the heart. As they were made upon the isolated heart, they would appear to leave unassailed the position that the use of low percentages, if continued sufficiently long, may bring about a fatal result by inducing paralysis of the respiratory centre.

BROMOFORM.

BROMOFORMUM.—Bromoform. (Tribromomethane.) **Dose, 0.2 c.c. (3 ♏).**

ACTION OF BROMOFORM.

Bromoform, an analogue of chloroform, is anæsthetic and antispasmodic, and also has antiseptic properties. When inhaled, the narcosis produced by it is shorter than that of ether or chloroform.

THERAPEUTICS OF BROMOFORM.

It has been employed internally in influenza and spasmodic cough, and especially in whooping-cough. In the latter it is a remedy of considerable value, but must be employed with great caution, as a number of cases of poisoning from its use have been reported. As a rule, it is better in this affection to depend upon agents attended with less danger. On account of its high specific gravity it is likely to separate from mixtures unless very carefully compounded. It can be administered as follows: Bromoform, 1; alcohol, 8; compound tincture of cardamom, 8; glycerin, 48. Each fluid drachm (4 c.c.) contains the official dose.

ETHER.

ÆTHER.—Ether. (Ethylic Ether. Ethyl Oxide.) **Dose, 1 c.c. (15 ♏).**

Preparations.

1. **Oleum Æthereum.**—Ethereal Oil.
2. **Spiritus Ætheris.**—Spirit of Ether. **Dose, 4 c.c. (1 fl. dr.).**
3. **Spiritus Ætheris Compositus.**—Compound Spirit of Ether. (Hoffmann's Anodyne.) **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF ETHER.

External.—By its rapid evaporation when applied to the skin, ether produces a sensation of cold, and the part becomes **blanched** from the resulting contraction of the blood-vessels. When it is used in the form of a spray, this action is intensified, and marked **local anæsthesia** is caused. If, however, evaporation is prevented, or the ether is rubbed in, an irritant effect is produced, though less pronounced than in the case of alcohol or chloroform.

Internal.—In the mouth and stomach its effects are similar to those of alcohol and chloroform. It is a very prompt **carminative,** causing increased secretion of the glands and dilatation of the gastric vessels. By **reflex action** it also at once **stimulates the heart,** increasing the force and frequency of the pulse and raising the blood-pressure, and at the same time it excites respiration. It is absorbed rapidly and is not only a quickly acting **diffusible stimulant,** but also an **anti-spasmodic.**

Nervous System.—The action on the central nervous system in general resembles that of chloroform, but in some important particulars there is a difference. The respects in which the two differ, when given for **anæsthetic** purposes, are somewhat as follows:

1. Chloroform acts 36 to 48 times as powerfully as ether in paralyzing the heart. The pulse is not nearly so much affected by ether as by chloroform; while it may be somewhat slower than usual, it is full and strong.

2. Chloroform is 3 to 3½ times as depressant as ether to the medullary centres and the rest of the central nervous system.

3. Anæsthesia is produced with greater difficulty, more slowly, and often less powerfully with ether than with chloroform; consequently, the stage of excitement is usually more marked and prolonged, and naturally attended with more struggling.

4. It is necessary to give the ether in much more concentrated form in order to produce narcosis—about 70 per cent. of ethereal vapor to 30 per cent. of air.

5. Consequently, it is much more difficult to administer than chloroform.

6. Also it produces more irritation of the respiratory passages.

7. Ether is much more likely to irritate the kidneys.

8. Chloroform is much more agreeable to inhale. Its odor and taste are sweet and pleasant, and it causes less irritation and less feeling of suffocation.

9. Ether is eliminated more slowly, and the odor therefore lingers about the person for some time.

10. On account of its inflammability, ether is dangerous in the vicinity of an exposed flame or where the actual cautery is to be used. When artificial light, other than the incandescent electric, must be employed, the lamp should always be adjusted above the patient, since the ether vapor is heavier than air.

Kidneys.—From experimental researches it appears that in the dog, at least, ether anæsthesia has for some as yet unexplained reason a specific action upon the kidney, consisting of a constriction of the arterioles of the organ. This is entirely independent of any change in the general arterial circulation, since it is found from the carotid tracings that the blood-pressure is raised from the beginning. The vascular contraction in the kidney has a damaging effect upon the renal secretory cells, similar to that which follows clamping the renal artery; the kidney shrinks in bulk, and as the etherization progresses to deep narcosis there is a diminished secretion of urine, marked albuminuria, hæmaturia, and, finally, suppression. It would seem probable that in man a corresponding action is elicited.

Excretion.—So far as known, ether appears to be excreted only by the lungs.

THERAPEUTICS OF ETHER.

External.—An ether spray may be used in superficial neuralgia, where the benumbing of the nerve sometimes effects a permanent cure. It is also employed at times to produce local anæsthesia (by the cold resulting from the evaporation of the ether) for small operations, and it is particularly useful where thoracentesis or paracentesis abdominis is to be performed, or a simple incision made. As a rule, however, the hardness of the tissues caused by it is a serious objection as regards operations, while the subsequent reaction is liable to produce considerable tingling and pain, as well as oozing of blood from the wound. In any case where such local anæsthesia is used, the cold produced should not be intense enough to actually freeze the tissues, as this is apt to render the healing slow. Since it dissolves fat from the skin, ether may also be employed as a detergent before operations, the part to be operated on being washed with it after soap has been used. Ether being a good solvent of the active principles of many drugs and also of sebaceous matter, it has been strongly recommended as a menstruum for various remedies to be applied to the skin. The ether-spray has sometimes been successfully used in strangulated hernia, and its application to the spine has been followed by good results in some cases of chorea.

Internal. *Stomach.*—Ether is very useful in colic and some forms of dyspepsia. Small doses of Hoffmann's anodyne, which may be administered in camphor water, are efficient in expelling flatus from the stomach and are often of service in gastralgia and sick headache. A few drops of ether, added to cod liver oil, render it more tolerable to the stomach and facilitate its digestion and absorption, probably by increasing the secretion of pancreatic juice.

Heart.—On account of the rapidity of its action, ether is a cardiac stimulant of great value, and it is frequently employed in fainting, palpitation and heart-failure. According to circumstances, it may be given either by the mouth or by hypodermatic injection. The dose for the latter purpose is 1 c.c. (15 ♏). It is also a useful anti-spasmodic in asthmatic attacks.

Inhalation.—Ether is administered as a general anæsthetic for the same purposes as chloroform. On account of its greater safety, it is more commonly used in the United States. Some accidents with chloroform are no doubt due to carelessness, on account of the great facility with which it can be administered, but granting this, there can be no question that chloroform, as might be supposed from the points in which its action differs from that of ether, is the more dangerous agent of the two. From the published statistics it would appear that the immediate mortality with chloroform is from three to five times as great as with ether. The difference in the concentration required to produce anæsthesia and that which will cause serious impairment of the heart's action, or which will stop the respiration, is very much smaller in the case of the one than of the other. Hence the preference should be given to ether except when this is specifically contra-indicated, as in bronchitis, nephritis, etc. From clinical observation, as well as experimental research, it is clear that ether has a special tendency to produce kidney trouble, and as a rule, therefore, it had better be avoided when renal disease is present, and particularly when with this there is a tendency to pulmonary œdema. If employed at all, it should be administered with the greatest caution to those suffering from the various forms of acute or chronic kidney disease, or renal insufficiency from any cause. Both ether and chloroform have been shown to be highly dangerous in cases of diabetes. Much attention has of late been directed to fatalities occurring as sequelæ of surgical anæsthesia: in the case of chloroform more particularly in consequence of fatty degeneration of the heart and kidneys or of diabetic coma, and in that of ether from uræmia and from bronchitis, pneumonia and pulmonary œdema, especially in the subjects of nephritis. In a considerable number of instances death from pulmonary œdema with bronchial effusion and aspiration pneumonia has occurred in the course of a few days after etherization. It is claimed by many that these post-anæsthesia deaths are decidedly more frequent after ether than after chloroform, and, in fact, that their number is large enough to bring the total mortality from ether, immediate and secondary, quite up to or even beyond that of chloroform. Some surgeons, it may be stated, who formerly used ether almost exclusively, believing that if a fair estimate were made the fatal uræmias and pneumonias depending on ether, if properly credited to it, would reverse the record as it stands at present, are now chiefly employing chloroform. As it is very difficult, however, to distinguish between the results of the anæsthetic and the ordinary forms of disease, no very reliable statistics are as yet available in regard to the point at issue. The practice is now quite common of commencing ether anæsthesia with the preliminary inhalation of nitrous oxide gas, and in this way the disagreeableness of ether to the patient may be largely obviated and a more rapid and satisfactory narcosis secured. For the nausea and vomiting sometimes caused by ether the administration of 1 gm. (15 gr.) of sodium bromide has been recommended.

ÆTHER ACETICUS.—Acetic Ether. (Ethyl Acetate.) **Dose, 1 c.c. (15 ♏).**

ACTION OF ACETIC ETHER.

It resembles ether in its carminative, stimulant and antispasmodic properties, but as it is less volatile, its action is less prompt and more prolonged, and it is more irritating to the skin. While its inhalation will produce general anæsthesia, its effect in this respect is too slow for practical purposes.

THERAPEUTICS OF ACETIC ETHER.

On account of its agreeable odor and taste it is combined with other carminatives as a stimulant and antispasmodic. It is employed as an ingredient of Cologne water, and is sometimes applied externally with friction, as a resolvent and for the relief of rheumatic and other pains. The inhalation of its vapor allays laryngeal and bronchial irritation, and may also be found useful in nervous cough.

Division XI.—DRUGS ACTING ON THE ORGANS OF GENERATION.

A. Aphrodisiacs.—These are substances which increase sexual desire and power. They are supposed to act by stimulating, directly or reflexly, either the cerebral or spinal genital centre. The latter has been located in the lumbar portion of the cord, and irritation of it induces erection. It is conceivable that it may be excited by afferent impulses conveyed to it from various parts of the parts, but especially from the cerebrum and the genital organs. Its activity appears to be largely dependent upon the condition of the general health, and hence tonics and all measures promoting the bodily nutrition may act as indirect aphrodisiacs.

The following drugs are known as aphrodisiacs; their mode of action in this regard is not very clearly understood.

(1) **Strychnine.**
(2) **Cantharides.**
(3) **Alcohol.**
(4) **Cannabis Indica.**
(5) **Camphor.**
(6) **Phosphorus.**

Strychnine probably acts by raising the tone of the spinal centres, cantharides and camphor through reflex irritation from the urethral mucous membrane, alcohol and cannabis indica by their effect on the imagination, and phosphorus by improving the general condition, especially in chronic nervous exhaustion.

B. Anaphrodisiacs.—These are remedies employed to diminish sexual desire. They are supposed to act by decreasing the local circulation, by lessening the excitability of the nerves of the genital organs, or by depressing the genital centres. Most of them, it may be said, are probably effective by diminishing or removing some source of irritation which is reflexly producing an aphrodisiac effect.

Drugs used as anaphrodisiacs are—

(1) **Bromides.**
(2) **Potassium iodide.**
(3) **Opium.**
(4) **Belladonna.**
(5) **Hyoscyamus.**
(6) **Stramonium.**
(7) **Digitalis.**
(8) **Purgatives.**

Local applications of ice, or cold baths, are sometimes of service as anaphrodisiacs.

C. Ecbolics or **Oxytocics** are remedies which during or immediately after parturition increase uterine action.

They are—

(1) **Ergot.**
(2) **Cotton root bark.**
(3) **Hydrastis.**
(4) **Savin.**
(5) **Cimicifuga.**
(6) **Quinine.**
(7) **Powerful purgatives.**

Of these, ergot is by far the most important. Occasionally some of these drugs will act upon the gravid uterus to produce abortion before parturition has begun. Most of them have been used for this purpose with criminal intent.

D. Emmenagogues are substances used to increase the menstrual flow. Diminution of the menstrual flow is a symptom of a large number of conditions; so that the various drugs which are beneficial in any of these are indirect emmenagogues. Certain substances, however, appear to have a special action in increasing the menstrual flow. They are—

(1) **All Ecbolics.**
(2) **Manganese salts.**
(3) **Asafetida.**
(4) **Apiol.**
(5) **Myrrh.**
(6) **Guaiac.**
(7) **Cantharides.**
(8) **Borax.**

Among the many indirect emmenagogues the commoner are purgatives, iron, cod liver oil, and strychnine, which act by improving the general health. Hot foot- or hip-baths, especially if mustard be added, often aid the onset of menstruation.

E. Substances which depress Uterine Action.—These are employed to diminish or abolish the contractions of the gravid uterus.

They are—

(1) Bromides.
(2) Opium.
(3) Hydrated chloral.
(4) Viburnum.
(5) Cannabis indica.
(6) Chloroform.
(7) Antimony and potassium tartrate.

F. Drugs acting on the Secretion of Milk.

Galactagogues are drugs which increase the secretion of milk. The most prominent are:

Pilocarpus, Leaves of Ricinus communis, and **Alcohol.**—Of these pilocarpus is the most powerful, but its effects soon pass off. The leaves of the castor-oil plant are used, applied as a poultice, while a decoction of them is given internally at the same time. Alcohol has but a feeble effect, although the malt liquors have considerable reputation as galactagogues. The secretion is very dependent on the condition of the system at large; so that the best means of securing an abundant flow of milk is to maintain the general health.

Antigalactagogues are drugs which decrease the secretion of milk.

Belladonna, either given internally or applied locally, is usually efficient for this purpose, by paralyzing the nerves of the mammary gland.

The following *drugs* are *excreted by the milk,* and are therefore taken in by the nursing child:—Oil of anise, oil of turpentine, oil of copaiba, and probably all volatile oils, sulphur, rhubarb, senna, jalap, scammony, castor oil, opium, iodine, antimony, arsenic, bismuth, iron, lead, mercury, zinc, and potassium iodide. It is evident, therefore, that these remedies must be administered with care to the mother; for example, copaiba or turpentine will make the milk so unpleasant that the child will not take it. Such of the above list as are purgatives, when given to the mother, may cause diarrhœa in the child. Opium should not be given in large doses to the mother. On the other hand, mercury, arsenic, and potassium iodide may be administered to the child by being given to her.

A. APHRODISIACS.

PHOSPHORUS.

PHOSPHORUS.—Phosphorus. **Dose, 0.0005 gm. = 0.5 milligm.** ($\frac{1}{128}$ gr.).

Preparation.

Pilulæ Phosphori.—Pills of Phosphorus. **Dose, 1 pill.**

ACTION OF PHOSPHORUS.

Phosphorus has a **specific action on bones**, and especially those of young animals which are still growing. Under the influence of minute quantities the cancellous tissue tends to become compact, and there is a deposition of true bone of normal composition. This effect is attributed to the phosphorus acting as an irritant or stimulant to the bone-forming cells, and arsenic also appears to produce it to some extent. Small doses of phosphorus generally increase the number of red blood-corpuscles in man. Unless taken in a state of fine division or dissolved in oil, it is absorbed with difficulty, because of its insolubility in the fluids of the body and of its slow volatilization. The great mass of it, if finely divided, is absorbed unchanged and exists in the blood as phosphorus, and its action is due to this element rather than to its compounds. But little is known of its fate in the body. It is thought that a portion may perhaps be oxidized to phosphoric acid, and some of it is stated to be eliminated by the lungs, while some is excreted in the urine in obscure organic combinations. Phosphorus diminishes tissue waste, decreasing the elimination of urea and of carbon dioxide. As it is found as a necessary element in the nervous system, its action is that of a stimulant to its growth.

THERAPEUTICS OF PHOSPHORUS.

The best known liquid preparation is Thompson's solution: Phosphorus, 1; absolute alcohol, 300; glycerin, 720; and spirit of peppermint, 40; dose, 4 c.c. (1 fl. dr.). Phosphorus is especially indicated in osteomalacia, in rickets, and in cases of ununited fracture. Without doubt it promotes calcareous deposit in the healing of fractures. It is of value in convalescence from exhausting diseases, in nervous exhaustion, in neuralgia when dependent upon debility, in alcoholism, in sexual exhaustion, and in various suppurative affections.

TOXICOLOGY.

Acute Poisoning.—As phosphorus is quite accessible in the form of matches or vermin paste, poisoning by it, either accidental or suicidal, is not uncommon.

Symptoms.—For some hours no effect is observed. Then there is a burning pain in the abdomen, with nausea. The vomit, as well as the breath, has the characteristic garlic-like odor of phosphorus and it becomes luminous if heated with sulphuric acid. There is general depression, and this may amount to fatal collapse. Usually, however, the patient recovers from these effects and appears to be quite well for two, three or four days, when he again begins to suffer from vomiting, and the vomited matter is often bloody. There are also abdominal pain, distention and tenderness, and sometimes diarrhœa, and the stools may contain blood. With these symptoms there occurs jaundice, which soon becomes very marked, and the area of liver dullness is increased in consequence of fatty changes occasioned in that organ. The emesis, abdominal pain, and diarrhœa are explained by the same cause, the epithelial cells of the stomach and intestine undergoing fatty degeneration. There is considerable muscular weakness and pain, together with a small and quick pulse and general prostration. Slight fever is sometimes observed, but the temperature is often lowered in the later stages, though the patient usually complains of intense thirst. Hæmorrhages may occur in many different situations, and the immediate cause of these is fatty degeneration of the muscular coat of the smaller arteries throughout the body. The urine also may contain blood, as well as bile, leucin and tyrosin crystals, albumin, and an abnormal amount of ammonia. Peptone is sometimes excreted, and the phosphates and sulphates are apt to be increased from the augmented tissue-waste. The chlorides are much diminished, in consequence of the patient's taking little or no food. Sarcolactic acid appears in considerable quantity in the urine, and is sometimes accompanied by some sugar. This acid is regarded as diagnostic of phosphorus poisoning. The condition described lasts from five to eight days, when the patient usually dies of heart failure, as a result of fatty degeneration of the cardiac muscle from the direct action of the poison upon it. Towards the last, convulsions and coma may occur, and these are regarded as a result of disordered metabolism, rather than due to any direct influence on the central nervous system. Even when the symptoms are very severe, however, recovery is possible. With phosphorus burns none of the symptoms of phosphorus poisoning are presented.

Post-mortem.—As might be supposed from the above description, wide-extended fatty degeneration is a prominent feature of the postmortem findings, and in this respect phosphorus resembles arsenic, antimony and chloroform. This pathological change is most marked in the liver, but numerous fat globules are observed in the cells of many other organs, notably the kidneys and the gastric and intestinal glands, and also in the muscle fibres of the heart, stomach, intestines, smaller arteries, and often of the skeletal muscles. As to whether this fat is formed by the degeneration of the protoplasm of the cells in which it is found, or whether it is carried from other parts of the body and simply deposited in these cells, is as yet undetermined, but the weight of evidence appears to be decidedly in favor of the latter view. Another characteristic feature is the appearance of numerous hæmorrhages and ecchymoses. In addition to the fatty degeneration of the muscular coats of the arteries referred to, it is probable that the absence of clotting in the blood, due to the changes in the intestine and liver, which interfere with the formation of fibrin, is a factor in the causation of these. It has been noted that if the patient lives long enough, there may be a diminution in the size of the liver, and altogether the effects of phosphorus poisoning present a considerable resemblance to those of acute yellow atrophy of this organ.

Treatment.—As phosphorus is absorbed from the alimentary canal comparatively slowly, an attempt should be made in the early stages to remove it by emetics or the washing out of the stomach and by purges. Afterwards the object is to oxidize the phosphorus. Formerly copper sulphate was much lauded as an antidote, but recent researches appear to prove that it is itself a dangerous poison. Experiments on dogs have shown that old (ozonized) oil of turpentine, which contains oxygen, if administered before the poison is absorbed, is an antidote. Ordinary oil of turpentine, however, is worse than useless, for as phosphorus is soluble in oils, we simply aid in its absorption by giving any oily or fatty substances. Repeated and free inhalations of oxygen have been used, and this suggests that hydrogen dioxide may be efficacious when given by the mouth. Potassium permanganate has also been advised for the purpose of oxidizing the phosphorus. In the secondary stage alkalies are recommended in order to neutralize the excess of sarcolactic acid formed in the tissues.

Chronic Poisoning.—From the fact that the red or non-poisonous phosphorus is now generally employed in match factories, chronic poisoning, which was formerly frequently met with in those who worked among phosphorus fumes, has become a very rare occurrence. Such poisoning manifests itself in gastro-intestinal irritation and a peculiar necrosis of the jaws. The latter, which usually has its starting-point in carious teeth, begins with salivation and suppurative ulceration of the gums; after which there results a profound periostitis, involving the whole jaw. The lower jaw is more often affected. Phosphorus necrosis must be treated surgically on the same principles as other necroses. The diseased bone readily becomes the seat of tuberculous deposit, and sufferers from phosphorus necrosis not infrequently die from general tuberculosis.

1. **CALCII HYPOPHOSPHIS.**—Calcium Hypophosphite. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

2. **FERRI HYPOPHOSPHIS.**—Ferric Hypophosphite. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

3. **MANGANI HYPOPHOSPHIS.**—Manganese Hypophosphite. **Dose, 0.200 gm. = 200 milligm. (3 gr.).**

4. **POTASSII HYPOPHOSPHIS.** — Potassium Hypophosphite. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

5. **SODII HYPOPHOSPHIS.**—Sodium Hypophosphite. **Dose, 1 gm. (15 gr.).**

6. **ACIDUM HYPOPHOSPHOROSUM.**—Hypophosphorous Acid.

7. **ACIDUM HYPOPHOSPHOROSUM DILUTUM.**—Diluted Hypophosphorous Acid. **Dose, 0.5 c.c. (8 ♏).**

Preparations.

1. **Emulsum Olei Morrhuæ cum Hypophosphitibus.**—Emulsion of Cod Liver Oil with Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

2. **Syrupus Hypophosphitum Compositus.**—Compound Syrup of Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

3. **Syrupus Hypophosphitum.**—Syrup of Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF THE HYPOPHOSPHITES.

The hypophosphites were introduced under the supposition that they exert some special influence on nutrition. Practically the whole of the hypophosphite administered can be recovered from the urine, showing that they are not oxidized to phosphates in the tissues, as was formerly believed to be the case. So far as investigations regarding their effects on nutrition has gone, no evidence has been furnished, according to the best authorities, that they have any further action than the other indifferent salts, such as the chlorides. The chief effect of ferric hypophosphite is regarded as undoubtedly due to its metallic iron.

THERAPEUTICS OF THE HYPOPHOSPHITES.

Notwithstanding the unsatisfactory experimental evidence of their value, these drugs are extensively used in cachectic conditions, especially tuberculosis, and are the basis of a large number of proprietary preparations. Following Churchill, they should be of chemical purity, neutral in reaction; the presence of free alkali or alkaline carbonates quickly giving rise to an atonic dyspepsia. In the early stages of phthisis (infiltration) the sodium salt should be administered and the sodium salt alone; if excavation is present the calcium salt is indicated, and this alone, provided that it does not suddenly check expectoration; when the sodium salt should be resumed. The potassium salt is a valuable expectorant in chronic bronchitis; but it has a very limited usefulness in phthisis. The hypophosphites, when administered intelligently, will improve nutrition and relieve some of the symptoms of this disease. If administered in too large doses, or simultaneously with other remedies, as arsenic, stimulants, strychnine, or cod-liver oil, they are likely to produce headaches and dyspepsia, and fail to cause improvement. The objection to the official syrups, namely, the use of the salts in combination, applies to nearly all of the proprietary preparations, with the addition that most of the latter contain impure salts, as well as a low percentage of hypophosphites, and are not scientific combinations.

Unofficial Preparations.

Calcii Glycerophosphas.—Calcium Glycerophosphate. **Dose, 0.30 to 1 gm.; 5 to 15 gr.**

Sodii Glycerophosphas.—Sodium Glycerophosphate. **Dose, 0.60 to 2 c.c.; 10 to 30 ♏,** usually hypodermatically.

ACTION OF THE GLYCEROPHOSPHATES.

The administration of these substances has been found to increase the solids of the urine, the urea and the salts, with but little effect on uric acid. They improve the nutrition of all organs, but more particularly that of the nervous system.

THERAPEUTICS OF THE GLYCEROPHOSPHATES.

Inasmuch as the urine of neurasthenics contains relatively large amounts of incompletely oxidized phosphorus, especially in the form of glycerophosphoric acid, the effort was made to replace this loss by the introduction of phosphorus into the organism in a form approaching, as nearly as is possible, that in which it exists in the nervous system. The indications for the glycerophosphates are conditions of nerve depression. If given subcutaneously they are at least as efficacious as testicular extract (*q. v.*), which owes its activity to its contained organic phosphates, and they possess the advantage of more accurate dosage. They are useful in various neuralgias, as sciatica, tic douloureux, Addison's disease, and in the symptom-complex known as neurasthenia. Chlorosis, albuminuria, phosphaturia and anæmia (the latter by iron glycerophosphate) have been benefited. In diabetes the general condition improves and the amount of sugar may diminish. These remedies should not be expected to rejuvenate senility, but are useful, even if slowly acting, adjuncts to the systemic treatment of an impaired nervous system.

C. ECBOLICS.

ERGOT.

ERGOTA.—Ergot. (Ergot of Rye.) **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Extractum Ergotæ.**—Extract of Ergot. (Ergotin.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Fluidextractum Ergotæ.**—Fluidextract of Ergot. **Dose, 2 c.c. (30 ♏).**
3. **Vinum Ergotæ.**—Wine of Ergot. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF ERGOT.

The effects of **cornutine** are quite distinct, in some respects at least, from those of the other constituents of ergot. Like picrotoxin, it produces a stimulation of the medulla oblongata, followed by paralysis. A rise in blood-pressure results from the stimulation of the vaso-constrictor centre. While the other medullary centres, the salivary, vagus, vomiting, respiratory, etc., are acted upon to some extent, the stimulating influence is most conspicuously shown in the production of convulsions, which are chiefly clonic in character. In the frog it acts, like veratrine, directly on the fibres of skeletal muscle, thus producing an alteration in the contraction of the muscles; but, unlike veratrine, it has no action on the heart. Under its influence contractions of a peristaltic nature have been observed in the stomach and intestine and also in the uterus, whether pregnant or not. The action of **sphacelic acid** consists in a constriction of unstriped muscle, especially of the blood-vessels, and a primary depression, resulting in paralysis of the central nervous system. The latter is usually the cause of death when it is given in fatal amount. The muscular constriction is apparently dependent on both a central and peripheral influence, and is shown most conspicuously in a tonic spasm of the arterioles, leading to a rise of blood-pressure. In man, the pig, and the chicken, but not in other animals, the contraction produced in some of the arterioles is so extreme and prolonged that a hyaline formation in the lumen and walls of the vessels takes place which effectually obstructs the circulation after the muscular coats have relaxed, and gangrene results. This is a typical action of sphacelic acid, and it is not met with to nearly the same extent in the case of any other known agent. It is observed in the greatest perfection in the comb of the cock, in consequence of the special arrangement of the blood-vessels in this structure. In all animals the acid causes contraction of the pregnant uterus, peristaltic under moderate doses and often tetanic when the quantity is large. From this sketch of the chief effects of these two substances the action of ergot itself may, it is hoped, be more clearly understood.

External.—Upon the skin ergot has no appreciable action, but upon mucous membranes it has somewhat of an **astringent** and **hæmostatic** effect.

Internal. *Gastro-intestinal Tract.*—Digestion is much impaired in consequence of the disturbance caused in the circulation, and vomiting is common, partly in consequence of the disturbed circulation and partly from the action of the cornutine on the medullary centre. **Increased peristalsis** of the intestine is induced by the stimulation of its muscular walls, and diarrhœa frequently results in chronic poisoning. The intestinal vessels are constricted, partly in consequence of the contraction of their own muscular coats and in part from that of the muscular fibres of the bowel.

Circulation.—A high blood-pressure is indicated by a hard and small pulse, which is usually slow also. The **rise in blood-pressure** may for a time be concealed by the slowness of the heart, but it is always **very marked,** and is one of the characteristic effects of ergot. It is dependent upon a **general contraction of the arteries,** which appears to be due in part to action on the vaso-motor centres and in part to direct action on the muscular coats of the vessels. Because it constricts the arterioles ergot is **hæmostatic.** Very large doses may paralyze the vaso-motor centres, with the effect of causing a fall of blood-pressure from vascular dilatation and cardiac depression. If ergot is taken continuously for a considerable time **gangrene** in various situations is apt to result from the vascular contraction and stasis of the blood stream, with coagulation and hyaline thrombosis. This is a prominent feature of chronic poisoning, which is known as **ergotism,** and it was frequently met with in former times among the lower classes of Europe, who after poor harvests especially were obliged to use bread contaminated with ergot.

Nervous System.—Besides the gangrenous form of chronic ergot poisoning, the other principal form is the **convulsive.** The differences in the several varieties of ergotism are explained by the different actions of the constituents of the drug and by the fact that they may act partly on the blood-vessels and in part directly on the central nervous system. In some epidemics both the gangrenous and convulsive forms have been present, but, as a rule, one has been much more prevalent than the other. In convulsive or spasmodic ergotism there are at first formication, itching and tingling of the surface, followed by numbness and local anæsthesia. Not infrequently anæsthesia and hyperæsthesia are found at the same time in different parts, or even in the same part. These manifestations commence in the hands and feet, and then spread over the whole body. This disturbance of sensation even affects the alimentary canal, so that there may be present at once both voracious hunger and loss of appetite. At the same time there are much weakness and depression, often with severe headache and giddiness, as well as central disturbances of the special senses, such as dimness of vision and impairment of the hearing. There may follow **convulsions**, usually clonic in character and often epileptiform, and these have as sequelæ contractures in the limbs and sometimes in the trunk muscles. The disease was immediately fatal in a large proportion of cases in earlier times, and when recovery took place it was apt to be followed by more or less loss of intellectual power, and in some instances by complete dementia.

Uterus.—One of the most prominent features of the action of ergot is its property of exciting **contractions in the pregnant uterus.** Whether the ecbolic effects of ergot are due to its action on the uterus itself or on the nervous centres is still an unsettled question. Its action upon the unimpregnated uterus appears to be the same in kind, but less marked in degree, and of much less constant occurrence.

The saliva, perspiration, urine and milk are diminished by ergot, and this is supposed to be due to the **general vascular contraction** caused by it.

THERAPEUTICS OF ERGOT.

Ergot is chiefly used for the purpose of insuring tonic contraction of the uterus after parturition, and thus guard against the occurrence of post-partum hæmorrhage. In case severe hæmorrhage is threatened, it is advisable, in order to obtain a more prompt effect, to administer it hypodermatically. The modern practice is to forbid the use of ergot until after the expulsion of the placenta. The only possible exception to this restriction is during the second stage of labor in cases where it may seem to be indicated as a prophylactic against post-partum hæmorrhage. Even under these circumstances it should never be given if there be the slightest mechanical obstacle to delivery, or if the fœtal head be high up in the pelvic canal. That ergot is justifiable in only very exceptional instances is illustrated by the fact that out of twenty-seven cases recorded by one authority in which it was employed during the second stage on account of inertia uteri, spontaneous delivery occurred in only seven. If the remedy is made use of at this period of labor, it is essential that the fœtal heart should be carefully watched, so that in case of threatened asphyxia instrumental delivery may be promptly resorted to. One objection to the use of ergot before delivery is that the uterine contractions induced by it are likely to become more and more severe and prolonged, so that ultimately the continued pressure may endanger the life of the child, while if serious mechanical obstruction is present, even rupture of the uterus may be caused. If employed before the membranes have ruptured, it may prevent the further dilatation of the os uteri and, through the constriction of the uterine vessels, deprive the fœtus of its blood supply. When given, as has been a very common practice, at the time of the passage of the child's head, it is likely to produce its effect prematurely, and thus to give rise to hourglass contraction and interfere with the expulsion of the placenta.

Ergot enjoys some reputation as an internal hæmostatic, and in addition to uterine hæmorrhage, it has been employed in epistaxis, hæmoptysis, hæmatemesis and renal and intestinal hæmorrhage. While some authorities regard it with much favor, it is certainly by no means uniformly successful, and the marked increase of blood-pressure which it causes may prove a serious objection to its use. In all cases where it is given it is of great importance that the preparation should be a reliable one, and that a sufficient quantity should be exhibited. Thus, if the fluidextract is selected, it is advised that in urgent cases 4 to 8 c.c. (1 to 2 fl. dr.) should be given every half-hour or hour. Ergot is often combined with ipecacuanha or astringents in these cases. The special indication for its use in hæmorrhage is regarded as a want of tonicity of the vessels. Where an especially prompt effect is required it should be administered subcutaneously, and this method is often preferable in hæmatemesis on account of the irritability of the stomach. With suitable means for improving the quality of the blood, it is regarded by some as very serviceable in the hæmorrhagic diathesis, but it is not to be relied upon alone. In aneurisms, and especially those beyond the reach of surgical treatment, ergot may prove distinctly valuable. By its action in slowing the heart and causing such contraction of the arterioles as to induce a marked increase of blood-pressure, the coagulation of the blood in the aneurismal sac is promoted. In small aneurisms of the peripheral main arterial trunks it is thought possible that it may effect a cure by means of the contraction resulting from its direct action on the unstriped muscular fibres in the affected portion of the vessel. It is also recommended in miliary aneurisms of the intra-cranial arterioles, giving rise to such symptoms as vertigo, epistaxis, headache and tinnitus aurium; likewise when there is a sluggish and partially obstructed state of the intra-cranial veins, usually due to chronic arteritis and accompanied by hebetude, dizziness, epistaxis, etc. In certain forms of mental disease, such as recurrent mania, chronic mania with lucid intervals, and epileptic mania, when associated with cerebral hyperæmia, ergot has been found useful. Much success is also claimed for it, when given in large doses, in congestion of the spinal cord and meninges and in acute myelitis, as well as in the congestive form of migraine. Its hypodermatic use in cerebro-spinal meningitis is highly recommended by some writers, and in the epidemic variety of this disease it is claimed as one of the remedies from which the best results are to be expected. Other conditions in which it has proved of service are acute conjunctivitis and blepharitis, congestive dysmenorrhœa, amenorrhœa dependent on plethora, incontinence of urine caused by a paretic or paralytic state of the bladder sphincter, distention of the bowels after abdominal operations, and some forms of spermatorrhœa. It has also been used to check the night-sweats of phthisis and as an antigalactagogue. It is sometimes beneficial in uterine fibroids and polypi, and good results have been obtained from the long-continued use of ergotin in chronic metritis. Ergotin, especially when combined with opium and nux vomica, has been found highly useful in persistent chronic diarrhœa.

Not infrequently it is desirable to use the fluidextract of ergot in combination with ferric chloride. The inky mixture which results, by reason of the tannic acid contained in the ergot, may be clarified by the addition of a little citric acid, and chloroform water is a good flavoring agent for it.

COTTON ROOT BARK.

GOSSYPII CORTEX.—Cotton Root Bark. **Dose, 2 gm.; 30 gr.**

ACTION OF COTTON ROOT BARK.

Cotton Root Bark has the same action as ergot, and is an emmenagogue and an abortifacient.

THERAPEUTICS OF COTTON ROOT BARK.

It is used as a uterine hæmostatic in the treatment of menorrhagia and metrorrhagia from various causes, and particularly from uterine fibroids.

HYDRASTIS.

HYDRASTIS.—Hydrastis. (Golden Seal.) **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Fluidextractum Hydrastis.**—Fluidextract of Hydrastis. **Dose, 2 c.c. (30 ♏).**
2. **Glycertium Hydrastis.**—Glycerite of Hydrastis. **Dose, 2 c.c. (30 ♏).**
3. **Tinctura Hydrastis.**—Tincture of Hydrastis. **Dose, 4 c.c. (1 fl. dr.).**

HYDRASTINA.—Hydrastine. **Dose, 0.010 gm. = 10 milligm. (1/6 gr.).**

HYDRASTININÆ HYDROCHLORIDUM.—Hydrastinine Hydrochloride. **Dose, 0.030 gm. = 30 milligm. (1/2 gr.).**

ACTION OF HYDRASTIS.

Hydrastis is a stomachic tonic, and the large amount of berberine in its composition would seem to give it a place among the **simple bitters.** In moderate doses it promotes appetite and digestion, increasing the gastro-intestinal secretions and the **flow of bile.** Its general action is due principally to the alkaloid hydrastine. This primarily stimulates the centres of the medulla oblongata, causing slowing of the heart, increased arterial tension, and a quickening of the respiration. The **rise in blood-pressure** is due to **constriction of the arterioles.** Under larger amounts there is a stimulation of the spinal cord similar to that caused by strychnine and causing clonic convulsions, followed by tonic convulsions and tetanus. Furthermore, it weakens and paralyzes muscle, an action which is confined to the heart in warm-blooded animals, but affects the muscles generally in the frog. In consequence of the cardiac depression the blood-pressure falls, and eventually both the medulla and cord are paralyzed, death occurring from **failure of the respiration.** The constriction of the arterioles is not due, apparently, to any direct action on the walls of the vessels, but rather to the stimulation of the vaso-motor centre. There seems to be no very satisfactory ground for the assertion, made by some writers, that hydrastis produces contraction of the uterus, from action on the muscle. The drug has decided **antiperiodic** properties. The behaviour of hydrastine towards oxidizing substances has led to the supposition that this alkaloid is changed into hydrastinine in the body, but this is disproved by the fact that it is excreted unchanged in the urine. Hydrastinine has been found to cause a much greater constriction of the peripheral vessels, as well as less depression of the heart, than hydrastine. It is also stated to differ from the latter in producing no marked disturbance of the centres of motion except when given in enormous doses, which paralyze the nervous system.

THERAPEUTICS OF HYDRASTIS.

External.—Hydrastis is much used empirically for subacute and chronic inflammations of the mucous membranes. It may be that the benefit derived from it is due in great measure to its action in causing the contraction of dilated blood-vessels. The various preparations, diluted with water, may be employed as injections in gonorrhœa, vaginitis, leucorrhœa, otorrhœa, and nasal catarrh, and as lotions for syphilitic mouth-lesions, mercurial or aphthous stomatitis, follicular pharyngitis, fissured nipples, hyperidrosis, acne, seborrhœa, and various other conditions. A mixture of equal parts of the fluidextracts of hydrastis and ergot has been used as a local application in fissure or prolapse of the anus, ulcerations of the rectum, hæmorrhoids, and ulcerations or erosions of the os uteri. In the form of ointments hydrastine and hydrastinine hydrochloride may be used for unhealthy ulcers, sloughing sores, chancroids, etc.

Internal.—Hydrastis is very useful in gastric catarrh, especially when induced by chronic alcoholism, and, combined with other appropriate remedies, often proves of service in intestinal indigestion and various forms of dyspepsia. In chronic catarrh of the intestine, even when ulceration has occurred, it may prove of great service, and it is especially esteemed in duodenal catarrh accompanied by catarrh of the gall-ducts and jaundice. It is employed to a considerable extent in uterine disorders such as menorrhagia and dysmenorrhœa, and also to check the growth of uterine tumors. For the arrest of hæmorrhage hydrastinine hydrochloride is to be preferred, but while this is valuable in other uterine hæmorrhages, it has little or no effect in post-partum hæmorrhage, so that it would seem highly probable that hydrastis has no action on the uterine muscle. On account of its marked action in constricting the arterioles in general, hydrastinine should prove of service in hæmorrhages other than uterine. As an antiperiodic, hydrastine, while much inferior, is ranked by some writers as next in value to quinine. In chronic malarial cachexia it may be given with iron preparations.

SAVIN.

SABINA.—Savin. **Dose, 0.5 gm. (7½ gr.).**

Preparation.

Fluidextractum Sabinæ.—Fluidextract of Savin. **Dose, 0.3 c.c. (5 ♏).**

OLEUM SABINÆ.—Oil of Savin. **Dose, 0.05 c.c. (1 ♏).**

ACTION OF SAVIN.

Oil of savin has the same action as oil of turpentine, but it is more marked. Thus, externally it causes great redness, pain vesication, and even pustulation. Internally it may produce severe gastro-intestinal irritation, with vomiting, abdominal pain, and purging. In its excretion through the kidney and the mucous membranes of the genito-urinary tract it severely irritates them, and hæmaturia, scanty urine, and pain on micturition may follow its use. The point in which the action of oil of savin differs from that of the oil of turpentine is that it powerfully irritates the **ovaries and uterus**, causing hyperæmia of these organs and accelerating menstruation. It also induces contractions of the pregnant uterus, and therefore it is an **ecbolic.**

THERAPEUTICS OF SAVIN.

A cerate made from the fluidextract, 1, in rosin cerate, 4, has been used as a powerful counter-irritant, and internally savin may be given as an emmenagogue; but, on the whole, its use is to be discouraged, as it is so liable to cause serious gastro-enteritis. It has often been administered as an ecbolic with criminal intent, but it is rarely used in medicine.

CIMICIFUGA.

CIMICIFUGA.—Cimicifuga. (Black Snakeroot. Black Cohosh.) **Dose, 1 gm.; 15 gr.**

Preparations.

1. **Extractum Cimicifugæ.**—Extract of Cimicifuga. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**
2. **Fluidextractum Cimicifugæ.**—Fluidextract of Cimicifuga. **Dose, 1 c.c. (15 ♏).**
3. **Tinctura Cimicifugæ.**—Tincture of Cimicifuga. **Dose, 4 c.c. (1 fl. dr.).**

ACTION OF CIMICIFUGA.

Cimicifuga is a bitter and to some extent a cardiac stimulant, slowing the action of the heart, but increasing its force. Its action in this respect is not important. In large doses it depresses the heart and vaso-motor system. In frogs it paralyzes the sensory side of the spinal cord, producing complete anæsthesia, with loss of reflex activity, at a time when voluntary movement is still preserved. The respiration is depressed and finally arrested. Cimicifuga is said to cause uterine contractions.

THERAPEUTICS OF CIMICIFUGA.

It has been employed in a great variety of conditions. Among them may be mentioned dyspepsia, fatty and irritable heart, dysmenorrhœa, amenorrhœa, subinvolution, rheumatism, neuralgia, chronic bronchitis, and especially chorea. That it is of very much benefit beyond that accomplished by a simple bitter is open to question. It has been asserted that it sometimes promptly cures urticaria of nervous origin after the failure of other treatment.

D. EMMENAGOGUES.

MANGANESE.

MANGANI DIOXIDUM PRÆCIPITATUM.—Precipitated Manganese Dioxide. (Black Manganese Oxide.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

MANGANI SULPHAS.—Manganese Sulphate. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

ACTION OF MANGANESE SALTS.

When given by the mouth they exercise an effect only in so far as they are dissolved in the secretions. In large amounts they cause gastro-intestinal irritation, and in smaller doses have some astringent action. When given by subcutaneous injection they cause descending paralysis of the brain and spinal cord in frogs, and may give rise to epileptiform convulsions in mammals. These salts, and especially the dioxide, are thought by many to have a specific influence upon the uterus. Like the dioxide, manganese sulphate in small doses has a somewhat astringent effect, but larger amounts (2 gm.; 30 gr.) cause vomiting and purging, in consequence of the local irritation of the stomach and intestine. As in the case of iron, only a very minute quantity is absorbed from the alimentary canal, and no constitutional symptoms have been observed from its prolonged administration by the mouth to animals.

THERAPEUTICS OF MANGANESE SALTS.

Manganese dioxide has been used empirically as an emmenagogue and is probably the most certain agent of the kind when administered in maximum dose. The sulphate has been used as a cholagogue purgative, but on account of its irritating properties it is a very unsafe remedy. Its action upon the uterus is much less pronounced than that of the dioxide.

APIOL.

Apiolum.—Apiol (unofficial). (Parsley.) **Dose, 0.60 to 1 c.c.; 10 to 15 ♏.**

ACTION OF APIOL.

Apiol in large doses acts as a cerebral and circulatory stimulant. It is also believed to have a special action on the uterine circulation.

THERAPEUTICS OF APIOL.

It is useful in amenorrhœa, scanty menstruation, and dysmenorrhœa when administered immediately before the expected period in cases in which these conditions are due to a want of ovarian activity; that is, where direct emmenagogues are required.

E. SUBSTANCES WHICH DEPRESS UTERINE ACTION.

VIBURNUM.

VIBURNUM PRUNIFOLIUM.—Viburnum Prunifolium. (Black Haw.) **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Viburni Prunifolii.—Fluidextract of Viburnum Prunifolium. **Dose, 2 c.c. (30 ♏).**

VIBURNUM OPULUS. — Viburnum Opulus. (Cramp Bark.) **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Viburni Opuli.—Fluidextract of Viburnum Opulus. **Dose, 2 c.c. (30 ♏).**

ACTION OF VIBURNUM.

Viburnum is believed to be an antispasmodic, diuretic and tonic.

THERAPEUTICS OF VIBURNUM.

It is especially used in the nervous diseases of pregnancy and to prevent miscarriage. It has considerable reputation as a remedy for spasmodic dysmenorrhœa, in the treatment of after-pains, and in menorrhagia. This remedy has been in extensive use for more than thirty years and is undoubtedly of value.

DIVISION XII.—SERUMS AND ANTITOXINS.

SERUMS AND ANTITOXINS.

Serums have been classed by some among alterative remedies, and there is a certain amount of reasonableness in this designation; but their manner of action and the methods by which they are administered are so different from those of ordinary alteratives that it seems preferable to give them in a division by themselves. To the class of substances (believed to be of albuminous nature) produced in the animal organism by pathogenic germs which is deleterious to the animals themselves the name **toxin** has been given, while to a different class of substances, also albuminous and also produced by the same germs, but which is inimical to the bacteria, the name **antitoxin** has been assigned. The toxin acts both as a local and systemic poison, and by its hostile influence upon the bacteria the antitoxin tends to counteract both of these effects. The precise *modus operandi* is as yet unknown, but it is thought probable that the antitoxin affects the protoplasm in such a way as to render it capable of resisting the action of the toxin. It is to be noted, however, that the antitoxin has been demonstrated not to be a germicide, and thus capable of killing the pathogenic organism; so that there is still considerable mystery as to just how it produces the beneficial effects observed from it. The serums are:

(1) Antidiphtheric Serum.
(2) Antitetanic Serum.
(3) Antistreptococcic Serum.
(4) Antipneumococcic Serum.
(5) Antivenomous Serum.
(6) Antiplague Serum.
(7) Anticholera Serum.
(8) Antityphoid Serum.

Antitoxins. Antidiphtheric and antitetanic serums are known also as antitoxins. The only official serum is the antidiphtheritic.

Serums, other than antitoxins or nutrient serums, are attenuated cultures made from pathogenic germs, and often called **vaccines,** the administration of which is designed to confer immunity from the special disease represented by the germs from which the cultures are made.

For the sake of convenience Nutrient Serum, which is supposed to replace the blood serum, and also Hydrophobia Antidote, although it is neither an antitoxin nor a serum, are considered in this Division.

SERUM ANTIDIPHTHERICUM.—Antidiphtheric Serum. Diphtheria Antitoxin. **Dose, 3000 units. Immunizing dose for well persons, 500 units.**

ACTION OF ANTIDIPHTHERIC SERUM.

Antidiphtheric serum has a favorable effect upon all the symptoms of diphtheria and also a marked influence in preventing the occurrence of sudden heart-failure which constitutes one of the great dangers of the disease. The temperature, however, is less affected than the other symptoms. Statistics collected from reliable sources afford overwhelming evidence as to the value of antitoxin in reducing the mortality from diphtheria. They also show that the frequency of laryngeal diphtheria is diminished by its use, and that the mortality of patients upon whom intubation or tracheotomy has been practiced is likewise diminished. Furthermore, the time during which the tube must be worn is decreased. After the serum has been employed, it is found that although the bacilli continue to be present, the formation of membranous exudation ceases, and that which is already present rapidly disappears. Consequently, if antitoxin be used early, the membrane rarely extends from the fauces into the larynx. It is not until twenty-four hours after injection, however, that the maximum effect of the antitoxin is observed. It is stated that the frequency of the occurrence of post-diphtheritic paralysis is not diminished, although the percentage of recoveries in cases with paralysis is slightly increased.

The use of the antitoxin is sometimes attended with untoward effects, but as a rule these are of very little importance. That they are not due to the antitoxin itself, but to something else in the serum, seems to be shown by the fact that they may result from the injection of the simple serum of animals. The most common of these is a rash, usually erythematous in character, but sometimes resembling measles or urticaria, and another is pain and swelling in the joints. Somewhat rarely there have been observed an irregular temperature range and, consecutively, emaciation and death; evidently pointing toward an acquired septicæmia. Further, in a few cases an early fatal result has been reported. It has been shown that in a fatal issue nephritis is the cause of death in a majority of instances, and clinically hæmorrhagic nephritis is by no means rare.

THERAPEUTICS OF ANTIDIPHTHERIC SERUM.

As the mortality of the disease when antitoxin is used increases in proportion to the lateness of its employment, it is evident that the administration should be commenced at the earliest possible moment. It is the safest plan to give antitoxin on a clinical diagnosis, without waiting for a bacteriological culture. Inasmuch as this remedy militates solely against the infection of the Klebs-Loeffler bacillus and clinically most cases of diphtheria are cases of mixed infection, the usual local antiseptic and general supporting measures must not be omitted. The danger of antitoxin lies in the horse-serum, for, many years before antitoxin was made, the results of injection of an alien serum had been pointed out. Concentrated serums then should be preferred in that they give the largest amount of antitoxin with the smallest amount of serum. In cases of moderate severity it is recommended that a dose of 5000 units (10 c.c. of serum containing 500 units per c.c.) should be given at once. A second injection may not be required, but if the symptoms demand it, the dose should be repeated two or three intervals of twelve hours. In severe cases, or in late, the dose should be 8,000 to 10,000 units. If no amelioration of the condition is observed within two or three days, the further continuance of the treatment appears to be useless. The injections are usually made, with a specially devised syringe, between the shoulders or on the side of the abdomen, and should be given under strict aseptic precautions.

So far as prophylaxis is concerned, the question is still *sub judice*. Many failures are reported, and, indeed, instances of reinfection have occurred even after suitable doses of antitoxin have been used during a previous attack.

Unofficial Preparation.

Serum Antitetanicum.—Antitetanic Serum. Tetanus Antitoxin. **Dose, 10 to 20 c.c.; 2½ to 5 fl. dr.**

ACTION OF ANTITETANIC SERUM.

While diphtheria is recognized by the local inflammation long before the nerves and heart have become affected, tetanus is first recognized only when the poison has gained access to the central nervous system. The hypothesis has been advanced that the toxin of the tetanus bacillus has a chemical affinity for nerve-tissue, and enters into chemical combination with and destroys such tissue, and that the convulsions result from the changes thus brought about in the nerve centres. Furthermore, that the antitoxin, having no such chemical affinity, is capable of neutralizing only the toxin that may still remain in the circulation, and naturally cannot have any effect on the destructive lesions already present in the centres. While antitetanic serum possesses antitoxic, it has no antibacterial properties.

THERAPEUTICS OF ANTITETANIC SERUM.

In view of the extreme gravity of the disease, in acute and rapidly developing cases it would seem advisable to employ the serum freely at the earliest possible moment in every case of tetanus. The injections may be repeated every six or twelve hours at first, and afterwards at longer intervals if there is evidence of improvement. In some instances the antitoxin has been injected directly into the brain, after trephining the skull, and in others into the spinal cord, and this is preferable in severe cases. In any case of injury in which there appears to be a likelihood of the development of tetanus the use of the serum as a prophylactic is advisable.

It is a well-known fact that tetanus antitoxin has proved far less successful than diphtheria antitoxin, and quite recent investigations have presented an explanation of the difficulties met with in the use of this serum. In these it was found that not only is the tetanus toxin carried to the central nervous system along the motor nerves, but also that the toxin gains entrance to the nerves through the motor end-plates, that it does not reach the central nervous system by any other route than the nerves, that tetanic rigidity is altogether a result of central irritation, and that the latent period between the injection of toxin (in experiments on animals) and the onset of tetanic symptoms is almost altogether due to the time required for the toxin to pass along the motor nerves to the cord or brain. Furthermore, it was found that tetanus antitoxin is not carried along the nerves, and has practically no action except upon that toxin which has not yet entered into the motor axis cylinders. Other recent experiments also go to show that the toxin is absorbed only by the motor nerves; the antitoxin only by the circulation and lymph. This peculiar mechanism, now demonstrated for the first time, brings the tetanus toxin in concentrated form upon the susceptible cells along the motor axis cylinders, and it furthermore places the toxin at an early period (and some time before the onset of symptoms) beyond the reach of the antitoxin. From these researches the following practical lessons have been drawn: (1) Subcutaneous, intravenous and subdural injections of antitoxin are of no value as measures to relieve tetanus when the symptoms have once appeared. (2) Injections of antitoxin, especially near the injected wound, will effectually bind any toxin present in the system: *i. e.,* toxin before it has been picked up by the motor end-plates. (3) It is probable that injections of antitoxin directly into the motor nerve leading from the infected wound, or even into the segment of the cord reached by this nerve, will have some influence upon the toxin. Still later the general treatment h ized by a leading authority as follows: (1) Immediate intravenous and subcutaneous injections to neutralize circulating toxin. (2) Immunizing or neutralizing injections at the highest level which the severity of the symptoms appears to justify: directly into the cord, or into the higher motor nerves, as the hypoglossal and spinal accessory. (3) Peripheral intra-neural injections as near to the cord as possible. Where amputation is not indicated or allowed, there is positive experimental evidence that nerve section will isolate the toxins in the limb. (4) Lymphatic absorption will diminish by the application of Bier's principle of passive hyperæmia or by circumcision of the limb. (5) Parenchymatous injections, *especially into the muscles,* may be found of distinct value in addition to subcutaneous and intravenous injections. (6) If possible, the local focus should be thoroughly eradicated. (7) We have no right to neglect symptomatic treatment. (8) Animal experimentation gives us no ground for hoping that any treatment whatever can be successful, when once the disease has progressed beyond a certain stage.

Unofficial Preparation.

Serum Antistreptococcicum. — Antistreptococcic Serum. **Dose, 10 to 20 c.c.; 2½ to 5 fl. dr.**

ACTION OF ANTISTREPTOCOCCIC SERUM.

Antistreptococcic serum has been used to a limited extent for some time, but it labors under the great disadvantage that different cultivations of apparently the same streptococcus show such variance that serum which is bactericidal to one cultivation may not be so to another.

THERAPEUTICS OF ANTISTREPTOCOCCIC SERUM.

It has been employed in various diseases in which infection is largely attributed to the streptococcus, such as erysipelas, malignant endocarditis, otitis media, thrombosis of the lateral sinus, and puerperal and surgical septicæmia; and trial may be made of it in any affection attended with the presence of streptococci. While the results are not infrequently disappointing, successful cases have been recorded in the disorders mentioned and also in scarlet fever, in which it has apparently proved useful sometimes in shortening the course of the disease and in preventing serious complications and sequelæ, such as otitis media and other suppurative processes. It has perhaps been found of most service in erysipelas and puerperal septicæmia, and it is recently reported to have been used successfully in inflammatory rheumatism, as well as in grave cases of scarlet fever. With an increased knowledge of its appropriate application there seems every reason to believe that the serum will prove a valuable addition to our therapeutic resources. The chief beneficial effects observed from its employment are a fall in temperature and a general improvement in the patient's condition. In many acute cases such effects have been noted after each injection; in these the serum may be administered two or three times a day, and in chronic cases once daily.

Unofficial Preparation.

Serum Antipneumococcicum. — Antipneumococcic Serum. **Dose, 10 to 20 c.c.; 2½ to 5 fl. dr.**

ACTION OF ANTIPNEUMOCOCCIC SERUM.

This serum is antibacterial, but does not appear to possess antitoxic properties. As in the case of antistreptococcic serum, there are serious difficulties in its practical application. Pneumococci, when derived from various sources, differ from one another in virulence and in cultural characteristics; hence a serum which proves protective in some instances may be of no value in others. Consequently, the results thus far obtained have not been very satisfactory.

THERAPEUTICS OF ANTIPNEUMOCOCCIC SERUM.

The serum is injected subcutaneously, and it is advised that the doses should be given twice a day until the temperature has subsided and the patient is convalescent. It is thought possible that it may be of more advantage in some other pneumococcal affections (such, for example, as infective endocarditis) than in pneumonia itself.

Unofficial Preparation.

Serum Antivenenosum.—Antivenomous Serum. (Antivenene.) **Dose, 10 to 30 c.c.; 2½ to 8 fl. dr.**

ACTION OF ANTIVENOMOUS SERUM.

This serum is protective in animals when employed before, at the same time, or shortly after inoculation with snake poison. The immunity conferred by it, however, is found not to last longer than six days. Up to a certain period after inoculation the serum is protective, even though symptoms of poisoning may have manifested themselves; but after that no amount of it, however large, can prevent a fatal result.

THERAPEUTICS OF ANTIVENOMOUS SERUM.

The serum should be administered as soon as possible after the snake bite. It may be given subcutaneously, but, on account of the greater rapidity of absorption, it is preferable to inject it into a vein, due aseptic precautions being taken. The results of this treatment thus far recorded leave no doubt of its value. In a number of instances recovery from the bites of venomous snakes has taken place even after well-marked symptoms of poisoning had made their appearance.

Unofficial Preparation.

Serum Antipestilens.—Antiplague Serum. **Dose, 10 to 20 c.c.; 2½ to 5 fl. dr.**

ACTION OF ANTIPLAGUE SERUM.

Antiplague serum is antibacterial. If, as is said to be the case, it also possesses antitoxic properties, these seem to vary with the method of preparation, and are certainly less pronounced than the antibacterial. The prophylactic vaccine (inoculation) contains the toxins derived from the bodies of the bacteria and also those produced in or diffused into the surrounding medium, which are stated to be so modified as to be almost entirely nonpathogenetic to susceptible animals. From three to five hours after inoculation there is a marked rise of temperature, with pain and swelling at the site of inoculation. While the temperature subsides in from twenty-four to thirty-six hours, the latter symptoms continue for several days.

THERAPEUTICS OF ANTIPLAGUE SERUM.

The antiplague serum, which is injected subcutaneously, should be administered as early as possible. Two or three doses should be given the first day, and one dose daily afterwards. The results thus far obtained with this serum have not been very encouraging. While in some cases it appears to do good, in others it has no effect. Such protection as is afforded by it has been found to last for only a few days, so that it is available as a prophylactic only under special circumstances.

The prophylactic vaccine should be injected, with strict aseptic precautions, into the subcutaneous tissue, preferably of the arm. It is stated that if the temperature does not rise as high as 38.8° C. (102° F.) in several individuals, the prophylactic is not up to the standard potency, and increased doses must be given. From an extensive use of this vaccine, particularly in India, its efficacy against plague appears to be clearly established, and it is believed that still more favorable results will be obtained when better methods of standardizing have been obtained and further improvements made in the method of preparation.

Unofficial Preparation.

Serum Anticholeraicum.—Anticholera Serum. **Dose, 10 to 20 c.c.; 2½ to 5 fl. dr.**

ACTION OF ANTICHOLERA SERUM.

This serum is antibacterial, but not antitoxic; it is said to protect against the living vibrios but not against their toxins. Two prophylactic vaccines have been used, one consisting of an emulsion in sterile broth of a fresh agar cultivation of virulent vibrios, and the other of an emulsion in sterile broth made from attenuated vibrios. They must be administered immediately after being made. One vaccine (inoculation) is used five days, or more, after the other, and they are injected into the subcutaneous tissue of the abdomen under strict aseptic precautions. There is a moderate, but brief, febrile reaction after the first vaccination, and a less marked one after the second.

THERAPEUTICS OF ANTICHOLERA SERUM.

As the serum has no antitoxic properties and as the disease runs such a rapid course, this serum does not appear to have any value in the treatment of cholera. On the other hand, prophylactic vaccination (inoculation) affords considerable protection against the disease. The statistics of its employment in India, however, go to show that while it undoubtedly diminishes the actual number of deaths from cholera, this is due to the smaller number of individuals attacked, in consequence of its prophylactic agency, and not to a decrease in the mortality. It appears, therefore, that if a vaccinated person contracts the disease, he has no better chance of recovery than an unvaccinated one. The dose is stated to be an eighth part of an emulsion made in sterile broth from the whole of an agar cultivation which has been incubated for twenty-four hours at a temperature of 35° C. (95° F.).

Recent investigations have shown that in many instances, at least, of the severe summer diarrhœa of infants and young children the infection is due to the bacillus of dysentery (Shiga's bacillus), and a serum against this has been prepared. Although but a very limited trial of this has as yet been made, the results obtained with it are stated to have been such as to lead to the hope that much may be expected from this method of treatment in the future. It has also been proposed to use an attenuated serum for prophylaxis against dysentery in persons exposed to the disease, as in the case of troops in tropical climates. It has been found feasible to protect small animals, like guinea pigs, against the bacillus. Such inoculation is attended with no danger whatever, but whether it is really effective as an immunizing agent can only be determined after extended trial and observation.

Unofficial Preparation.

Serum Antityphoideum.—Antityphoid Serum.

ACTION OF ANTITYPHOID SERUM.

The inoculation of dead typhoid bacilli, for prophylactic purposes, is made, with strict aseptic precautions, into the subcutaneous tissue of the abdomen. It is followed in three or four hours by local inflammatory reaction and by pyrexia which usually subsides within twelve hours. The average temperature observed is about 38.8° C. (102° F.).

THERAPEUTICS OF ANTITYPHOID SERUM.

It is advisable that the injection should be made in the evening, so that the patient may go to bed as soon as the symptoms make their appearance. In order to secure the best chance of success the inoculation may be repeated in a week. At present no definite conclusions can be reached as to the immunizing power of this method, but the inoculation appears to exercise a pronounced influence on the system, since it renders the blood serum capable of agglutinating typhoid bacilli. The dose of the strongest vaccine prepared is about 5 c.c. (8 ♏) and of the weakest, 1.5 c.c. (25 ♏).

As to the treatment of typhoid with antityphoid serum, there is as yet no reliable evidence that the procedure is of value. Cases thus treated have from time to time been reported, but the fact that the serum employed, so far as known, was not standardized renders it impossible to judge of results.

Unofficial Preparation.

Serum Nutriens.—Nutrient Serum. **Dose, 30 to 120 c.c.; 1 to 4 fl. oz.**

ACTION OF NUTRIENT SERUM.

At the time of the first introduction of diphtheria antitoxin a very large amount of the serum had to be injected, on account of its dilution; as much as 320 c.c. (10 fl. oz.) being used in two days for a child of five years. As the employment of such quantities was ordinarily found to be attended by no bad results, the idea was suggested that serum might be injected subcutaneously as a food, and a series of experimental researches in animals was accordingly instituted for the purpose of determining, as far as possible, the practical utility of this procedure. The results of these were as follows: The injection of small quantities of serum, by increasing the katabolism of the body, induces an increase of urinary nitrogen and a loss of weight, but when large quantities are employed, the loss from the increased katabolism caused is more than offset by the utilization of the serum as a food. It was thus found that in animals which were deprived of all other means of sustenance life was prolonged for a very considerable period by the subcutaneous injection of serum in sufficient quantity. Furthermore, it was ascertained that if the serum be heated to 65° C. (149° F.), this has the effect of destroying the bodies which produce increased nitrogenous katabolism and also those which give rise to certain untoward effects when the serum of one animal is injected into another of a different species. At the same time, the nutritive value of the serum remains unimpaired. These results have therefore been made use of in the human subject.

THERAPEUTICS OF NUTRIENT SERUM.

A horse-serum or sheep-serum, heated to the proper temperature, may be injected in a variety of conditions: as after grave abdominal operations when it is impossible or inadvisable to feed the patient by the mouth or rectum, in the regurgitation sometimes met with in post-diphtheritic paralysis, or in certain cases of gastric ulcer, typhoid fever, infantile diarrhœa, etc. The dose for an infant is 30 to 40 c.c. (8 to 10 fl. dr.), for a child, 60 to 80 c.c. (16 to 20 fl. dr.), and for an adult 100 to 120 c.c. (3 to 4 fl. oz.), and these doses may be repeated as required. Where the daily administration of the serum is called for, the injection should be made each time in a different part of the body in order to avoid undue local irritation. Goat serum or lymph has been employed to improve the general nutrition in many chronic diseases with some benefit. The exaggerated claims formerly made for it, however, have not been substantiated.

Unofficial Preparation.

Antidotum Rabiis.—Hydrophobia Antidote.

ACTION OF HYDROPHOBIA ANTIDOTE.

It has of late years been the practice when a person has been bitten by a dog supposed to be rabid to inoculate him on successive days with emulsion of rabbits' spinal cords of progressively increasing virulence, and it has been claimed that if this treatment is begun soon after the bite, hydrophobia does not usually develop. The spinal cords employed are taken from rabbits which have been inoculated with rabies. For inoculating the human subject, emulsions of dried cords are employed, and the virulence of the injection depends on the shorter or longer time for which the cord has been allowed to dry.

THERAPEUTICS OF HYDROPHOBIA ANTIDOTE.

The reports of the use of this suggest that some of the deaths after treatment may be due to it rather than to the bite. Inasmuch as the incubation period of hydrophobia is so extremely variable, the pathological findings so inconstant and the symptoms so diverse, there is much reason for doubting the existence of the disease in man. At least, the majority of alleged cases have been shown to have been those of various diseases (tetanus, septicæmia, hysteria). For this reason the antidote possesses but little interest save to those who are interested in spreading hydrophobia-phobia.

DIVISION XIII.—**ORGANIC EXTRACTS.**

The glands of the body, it is thought, are more or less interchangeable in their functions; so that if one is unable to do its work, another seems to assume extra activity. It is now a recognized fact that the blood is continuously supplied by certain glands with substances which are essential to the welfare of the system; so that a lack of these induces very serious results. It has been demonstrated also that the bad effects following the excision of the glands can be successfully obviated by the administration of the gland substance. The use of extracts of the glands of the body, known as animal or organic extracts, now has a legitimate place in medicine. They are usually active when given by the mouth, as well as by subcutaneous or intravenous injection, and thus present a marked contrast to the antitoxins, which, being proteid substances, are destroyed in the stomach. The chief object of the therapeutic employment of the organic extracts has hitherto been to supply a deficiency of the normal secretion, but at present their field of usefulness is becoming more and more extended, as their pharmacological action becomes more definitely understood and their practical therapeutic value is demonstrated in various pathological conditions. It seems altogether probable that the further developments in the subject of organo-therapy will be of great interest and utility. The organic substances most in use are:

(1) **Desiccated Thyroid Glands.**
(2) **Desiccated Suprarenal Glands.**
(3) **Thymus Extract.**
(4) **Pituitary Extract.**
(5) **Mammary Extract.**
(6) **Ovarian Extract.**
(7) **Testicular Extract.**
(8) **Splenic Extract.**

These substances might, with better reason than the anti-toxins and serums, be classified with the alteratives, but inasmuch as each one has a definite, aside from a general, action they are properly considered separately. The dried glands which are of the greatest practical importance are the thyroid and the suprarenal, and these only are official.

THYROID GLAND.

GLANDULÆ THYROIDEÆ SICCÆ.—Desiccated Thyroid Glands. (Thyroid Extract.) **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

Unofficial Preparation.

Iodothyrinum.—Iodothyrin. (Thyroiodin.) **Dose, .06 to .30 gm.; 1 to 5 gr.**

Action of Thyroid Gland.

Circulation.—The thyroid gland is thought to be probably the main organ of the body to furnish **vaso-dilating** material, and the administration of its substance has the effect of dilating the peripheral blood-vessels and reducing arterial tension. Consequently, the cutaneous surface becomes flushed and moist, and the cardiac action is more or less depressed. Unless its use is continued for a considerable time it has only a slight action on the heart muscle, but small doses increase and large doses diminish its force. The pulse-rate is quite constantly accelerated. Injections of thyroid extract into the circulation have been found to cause a fall in blood-pressure of relatively short duration. The only effect of ordinary doses observed on the blood is an augmentation of lymphocytes.

Alimentary Canal.—Loss of appetite and diarrhœa are quite frequently caused by large amounts and occasionally by small doses.

Nervous System.—Thyroid is a **cerebral stimulant,** capable of causing wakefulness, acuteness and rapidity of thought, and general brain activity. Given to excess, it produces headache, nervousness, restlessness, insomnia, palpitation, hot flushes, sweating, increased irritability of the reflexes, tremors of the extremities, and even convulsions.

Kidneys.—The quantity of **urine** is uniformly **increased.** This effect has been thought by some to be due to some specific action on the kidney, or to the changes in the circulation, but it may possibly result simply from the augmented excretion of urea and other urinary elements. In some instances sugar is found in the urine.

Metabolism.—A greatly increased oxidation is induced, both nitrogenous and non-nitrogenous bodies being rapidly used up. On this account there is an increased excretion of urea, uric acid, and xanthin bases in the urine and of carbon dioxide by the lungs. It is found that the first effects are upon fat, the proteids not being acted upon until this has been reduced to a certain minimum. These tissue changes result in a rise of temperature and a loss of body weight.

Excretion.—The elimination of the active constituents of thyroid gland takes place, so far as known, entirely through the kidneys.

THERAPEUTICS OF THYROID GLAND.

In man and the monkey one of the constant and characteristic effects of removal of the thyroid gland is a myxœdematous condition. At an early period there is an abundance of mucin and later there occurs a marked hyperplasia of connective tissue, embryonic in character. The skin is hard, rough and dry, because there is no secretion, and the hair loses its vitality and falls out. Among the other changes observed are, abdominal vaso-dilation, fatty and colloidal degeneration of the liver and kidneys, and hyaline degeneration of the arterial walls. All of these phenomena may be made to disappear by feeding thyroid. It is also a well known fact that atrophy of the thyroid gland always accompanies myxœdema, and it has been found that if patients suffering from this affection are treated with sheep's thyroid, all the symptoms disappear, usually in about six weeks. For the treatment of myxœdema after the symptoms have all disappeared it will be necessary, in order to prevent a recurrence, that the patient should take two doses a week for the rest of his life. Compressed tablets of the powder are very convenient to take, and are used to a considerable extent. Goitre may sometimes be favorably affected by thyroid, and the variety in which it is most beneficial is that known as the hyperplastic follicular. Complete disappearance is exceptional, but as a rule considerable decrease takes place, especially in the young. As recurrence is otherwise almost certain, the remedy must be continued indefinitely. In exophthalmic goitre it generally seems to be injurious, rather than beneficial. In sporadic cretinism excellent results are often obtained with it, and the brain symptoms share in the general improvement. Poorly developed young children are often benefited by it. In a few instances of imbecility in children, of tetany, and of climacteric insanity much improvement is reported to have been caused by it. In cases of arteriosclerosis where nitroglycerin in small doses is of value to reduce such disturbances from high tension as dizziness, sleeplessness and headache, thyroid has been found of marked benefit. It must be used with caution in persons suffering from organic disease of the heart. It has been observed in feeding thyroid for other purposes that not infrequently menorrhagia is produced, and it is asserted that in delayed menstruation, with or without anæmia, no drug is as efficient in causing normal menstruation as this. It has been given with success in chronic eczema and some other skin diseases, but the effects are by no means always permanent. This remedy has been advised and considerably employed in the treatment of obesity, but as it is not as efficient as some other means, and as its continued use in these cases is not unattended with danger, it is not to be commended.

Iodothyrin, a substance isolated from thyroid which possesses all the physiological properties of the gland extract, is now used to a considerable extent. A milk-sugar triturate of this is given in daily dose of 1 to 2 gm. (15 to 30 gr.).

Poisoning.—A condition somewhat resembling exophthalmic goitre in its symptoms, though without exophthalmos or increase in the size of the thyroid, and known as **Thyroidism**, may be induced by over-doses. Very large doses taken for a long time make patients thin; and also produce degeneration of the cardiac muscle, so that permanent disability may result. Surgeons are especially liable to make this error.

SUPRARENAL GLAND.

GLANDULÆ SUPRARENALES SICCÆ.—Desiccated Suprarenal Glands. (Suprarenal Extract.) **Dose, 0.250 gm. (250 milligm.); 4 gr.**

Unofficial Preparation.

Adrenalinum.—Adrenalin.

ACTION OF SUPRARENAL GLAND.

The principal effects of suprarenal gland, as demonstrated by experiment, are to increase the tone of all muscular tissue, mainly if not entirely by direct action, to **constrict** the **small arteries** through its action on the vaso-motor centre, and to **raise blood-pressure** more than any other known substance. Its action on the circulation is thus exactly the opposite of thyroid. The rise in blood-pressure is immediate, but it is to be noted that this effect is very brief, lasting less than a minute, and that it is not elicited at all when the administration is by the stomach. Suprarenal is a strong cardiac stimulant. The pulse-rate is slowed from stimulation of the pneumogastric centre in the medulla oblongata, and the heart muscle is affected in the same way as by digitalis, its systole being much strengthened and its diastole being often rendered less complete. The heart becomes more and more slowed, and is finally arrested in systole. The cardiac stimulation is not produced for some time after the constriction of the vessels. Additional actions of this substance are a depression of the respiratory centre, which may result in respiratory failure and death, and a diminution of peristalsis through peripheral action on the nervous mechanism. Its action on the muscles strongly resembles that of veratrine.

Certain unfavorable clinical results have been noticed to be coincident with the use of suprarenal solutions, and have been attributed to their effect. These doubtful results are stated to be: hæmorrhage, swelling and localized areas of œdema, retarded healing, sloughing, and unhealthy condition of wounds. Hence, with a view to determine the effect of suprarenal preparations on living protoplasm, a series of experiments was recently undertaken, and the main results of these, with the deductions, drawn from them, have been given as follows: If the results of observation on cold- can be applied to warm-blooded animals we may assume that the active principle of suprarenal gland has no affect upon the coagulation phenomenon, and that the danger of secondary hæmorrhage from softening of the clot is not increased by its use. If conclusions can be drawn from the behaviour of protoplasm in invertebrates under solutions of adrenalin of various strengths, it may be asserted that suprarenal preparations have a marked effect on cell-division of healing tissue and upon the proliferation of cells constituting granulation tissue. It may also be assumed that these solutions will have an effect depending on the strength of the solution, as well as the duration of the exposure, and that it is possible to kill cells or to prevent their activity, or retard cell-division. In this connection it should be remarked that other substances, especially alkaloids (atropine and aconitine), seem to act similarly. It would appear that the vitality of the protoplasm is weakened by suprarenal solutions. Experiments on the hearts of turtles and frogs show that suprarenal solutions are powerful muscle stimulants. In some of the invertebrates the suprarenal alkaloid is a powerful stimulant to contraction, and it affects the contractile tissue in a most characteristic and marked way. There is therefore warrant for asserting that, at least in some of the lower animals, suprarenal preparations have a most marked influence in interfering with the power of cell-division, the development of protoplasm, and the movement of cilia, and also in stimulating contractile tissue.

THERAPEUTICS OF SUPRARENAL GLAND.

It may be used as a local vaso-constrictor in minor surgery. On account of this property it may be applied to inflamed tissues so that these may be rendered anæsthetic by cocaine. For topical application, a filtered, freshly-made aqueous solution should be employed. It may be sterilized by heat without destroying its active principle. For internal treatment it is well to commence with .06 gm. (1 gr.) of the powder, three times a day, and progressively increase the dose. It should be given dry on the tongue and swallowed without water. It should never be given hypodermatically on account of the collapse which it causes when administered in this way. It is of great value in the treatment of "hay-fever," given internally and also applied locally. It is useful in the treatment of acute and chronic bronchitis, bronchial asthma, congestion and œdema of the lungs, hæmoptysis, and œdema of the glottis. It may be cautiously used in diseases of the heart, which, as has been stated, it stimulates from direct action on the heart muscle. Suprarenal extract has been used to a considerable extent in the treatment of Addison's disease, but without much benefit. It might perhaps be of service if it could be brought into the blood directly. In shock it has been proposed to inject a solution of one of the suprarenal preparations drop by drop into a vein, timing the rapidity of the injections by the behaviour of the pulse.

Adrenalin is the name proposed for a substance isolated from the suprarenal gland. This is employed in a 1 per thousand solution as a local astringent.

Unofficial Preparation.

Extractum Thymiamum.—Thymus Extract. **Dose, .20 to .30 gm.; 3 to 5 gr.**

ACTION OF THYMUS EXTRACT.

As the thymus gland atrophies in childhood and disappears after puberty, it is probable that it performs some important function in the development and growth of the young child. From the fact that it is so active during the period of greatest bone growth of the body, it has been inferred that it is concerned in the formation of bone salts; and a comparison of the salts found in the gland with those distributed in the bones lends color to this view. The thymus contains a larger amount of nuclein, and hence of phosphorus, than any other of the glands, and thymus extract is believed to be a reconstructive. It has some coagulant action on blood, and in this connection the statement to the effect that the thymus gland has been found absent in cases of hæmophilia is of interest. In dogs, after injections of the watery extract into the circulation, there have been observed lowering of the blood-pressure with acceleration of the heart's action, and this fall was not prevented by section of the vagi or by paralyzing them with atropine. It is thought probable that, as in case of thyroid extract, this effect is due to the organic extractive and mineral salts present, and not to any active principle. With large injections toxic effects have been produced, especially in young animals; the phenomena observed being agitation, intense dyspnœa, collapse, and finally death. In the study of the effects of extirpation of this gland, it has been shown that in many animals the thymus is not essential to life. Some experimenters have found no bad effects whatever resulting, while others have observed extreme voracity with emaciation for some time after the removal; the animals after one or two months recovering their normal condition. It is stated that as a result of the operation there have been noted an increase of the leucocytes and a diminution of the red corpuscles of the blood, and that nutritional changes have been the more marked the younger the animal. Among the morbid conditions in which a persistent and sometimes a large thymus has been observed are exophthalmic goitre, acromegaly, acute leukæmia and, more rarely, simple goitre.

THERAPEUTICS OF THYMUS EXTRACT.

It would seem to be indicated in rickets, hæmophilia and the scurvy of children. In the latter affection, as the blood is evidently inadequately supplied with its requirements, it is thought likely that it is the thymus gland that cannot get the salts which it needs; this being the cause of the bleeding and other symptoms of that condition. Fairly good results have been reported from its use in goitre, and it is possible that these may have been due to the fact that in the thymus there are traces of an iodine-containing compound similar to the iodothyrin of the thyroid. In exophthalmic goitre (Graves' disease) the results have not been so satisfactory, though many cases are stated to have improved under its use. One observer, after an extensive trial of it, concludes that thymus gland administered internally has no specific action in this affection, having no direct effect on the goitre, the heart, or the exophthalmos, though it possibly has some value in improving the general condition of the patients, and in this way may contribute towards their recovery. In pulmonary tuberculosis it has been found by some to aid the hygienic and medical treatment, its employment being based on the ground that the earthy salts of the bones are necessary to permanently encapsulate or heal tuberculous lung lesions. Thymus has also been given for hæmoptysis. A few cases have been reported in which it has appeared to do good in chlorosis, and it has been given with benefit in malnutrition and in defective development in children. Thus, it is said to be useful in pseudohypertrophic paralysis, and other conditions in which it has been recommended are leukæmia and idiopathic and pernicious anæmia.

Unofficial Preparation.

Extractum Pituitarium.—Pituitary Extract. **Dose, .20 to .30 gm.; 3 to 5 gr.**

ACTION OF PITUITARY EXTRACT.

The function of the pituitary secretion in the body is somewhat uncertain. Pituitary substance slightly stimulates the heart and constricts the blood-vessels, but is greatly inferior to suprarenal in this respect. Other effects which have been observed after subcutaneous injection in small animals are quickened respiration and paralysis of the hind limbs. The pituitary body is thought to be always hypersecreting in the condition of giantism and is stated to be always diseased in acromegaly. In cases of the latter when this secretion becomes disturbed there results almost continuous headache, sometimes excruciating in character.

THERAPEUTICS OF PITUITARY EXTRACT.

It has been used chiefly in acromegaly, and sometimes with good results. Of thirteen cases collected in which it was employed, in seven, varying degrees of improvement were recorded, in five there was no benefit, and in one the treatment appeared to make the patient worse. In one case where there was marked improvement this extract was given in combination with thyroid. In a number of instances the severe headaches accompanying acromegaly have been relieved by the administration of pituitary extract. It has been proposed to feed it to young dwarfs.

Unofficial Preparation.

Extractum Mammarium.—Mammary Extract. **Dose, .20 to .30 gm.; 3 to 5 gr.**

ACTION OF MAMMARY EXTRACT.

It is believed to have some influence on the uterus, though its action is not well understood.

THERAPEUTICS OF MAMMARY EXTRACT.

It has been given with alleged good results in uterine fibroma and carcinoma, also in menorrhagia, dysmenorrhœa and enlarged, sensitive uterus. In too frequent menstruation, and particularly in chlorotic girls, there is no remedy which acts so satisfactorily (delaying the period to the regular time) as mammary extract. It should be given for five or six days before the expected period.

Unofficial Preparation.

Extractum Ovarianum.—Ovarian Extract. **Dose, .20 to .30 gm.; 3 to 5 gr.**

ACTION OF OVARIAN EXTRACT.

But little is known of its pharmacological action. Fresh ovarian extract is said, when injected into the circulation in rabbits, to raise the blood-pressure, diminish the heart's action, and slow the respiration, and when administered to the human female also to increase the arterial tension. In the castrated animal it is found to increase oxidation to somewhat above the normal degree, but on the normal animal it has no such effect. Its administration does not prevent atrophy of the uterus after removal of the ovaries.

THERAPEUTICS OF OVARIAN EXTRACT.

Some time since it was suggested in cases of removal of the ovaries, and it has been given with more or less success in the various conditions following the functional loss of these organs, either through operation or disease. It has been employed to relieve congestion and ovarian neuralgia, and may be used when the functions of the ovaries are either partially or wholly arrested. It is reported to have a decidedly beneficial action not only upon typical climacteric disturbances, but also upon the psychical depression and constitutional affections, such as gout and psoriasis, which may make their appearance at this period. In five cases of epilepsy which appeared to be connected with the climacteric or with amenorrhœa much benefit is said to have been derived from its use. It has been employed in delayed or scanty menstruation, ordinary amenorrhœa, uterine fibroids, and exophthalmic goitre.

Unofficial Preparation.

Extractum Testicularium.—Testicular Extract. (Testicular juice.) **Dose, .20 to .30 gm.; 3 to 5 gr.**

ACTION OF TESTICULAR EXTRACT.

The theory has been advanced that certain organs supply to the body a natural ferment which is essential to health. When this ferment is absent the vital forces degenerate. Under the use of testicular extract the functions of organic life are performed with new vigor.

THERAPEUTICS OF TESTICULAR EXTRACT.

Favorable reports of its use in many hundreds of patients suffering from organic nervous diseases are on record, but the claims are so broad that further observations are necessary.

Unofficial Preparation.

Extractum Splenicum.—Splenic Extract. **Dose, .20 to .30 gm.; 3 to 5 gr.**

ACTION OF SPLENIC EXTRACT.

Excision of the spleen, or the serious impairment of its functions by disease, it is stated, is usually followed by marked tissue changes and great susceptibility to alterations of temperature, especially in malarial subjects. Scarcely anything is known of the action of splenic extract. According to some experimenters its subcutaneous injection produces no physiological effects, while others have found that in the dog intravenous injections cause first a prompt fall of blood-pressure, followed later by a pronounced and continuing rise, which again is succeeded by a slow return to the normal. It has been found that if it is given by the mouth in sufficient amount to produce effect it is apt to violently disturb the digestion and cause much pain, nausea and vomiting, and that administered hypodermatically it frequently causes marked local irritation and sometimes abscesses.

THERAPEUTICS OF SPLENIC EXTRACT.

In various disorders of the blood it has been employed with the idea of supplying to that fluid some material which may be required for its healthy condition. It has been pointed out that some secretion of the spleen possesses antibacterial properties, as indicated by such facts as the evident incompatibility of tuberculosis and malaria and by the enlargement of the spleen in acute infectious diseases, as if it were working against the germs of such affections. Accordingly, it was proposed that the splenic substance of animals immune against certain of these diseases, such as tuberculosis, malaria and typhoid fever, should be employed as a remedy in them. Splenic extract has been given with more or less benefit in exophthalmic goitre, and is stated to have improved the mental, as well as the general condition, of the patients in some cases of insanity.

DIVISION XIV.—DRUGS ACTING ON METABOLISM.

The action on metabolism of many of the drugs previously described has already been referred to. As our knowledge of the normal metabolism of the body is as yet limited, no further remarks on this subject need be made except as regards the individual drugs now to be considered. In this place it may be well to call attention to two names in common use, viz.: alterative and tonic.

Alterative is a vague term which cannot be accurately defined. It is often employed to cloak our ignorance of the exact action of a drug, but in general it is applied to agents which appear to modify the nutritive processes and thereby cure or alleviate many diseases of chronic type. They thus favorably *alter* morbid processes, as in the case of mercury in syphilis, but the *modus operandi,* of which almost nothing is definitely known, probably varies very greatly in the case of different drugs.

Tonic.—A tonic has been stated to be a drug which so influences nutrition as to increase the reconstruction or upbuilding of the tissue or tissues concerned. While this definition is not entirely adequate, it is perhaps as satisfactory as any that can be given. Many of the bitters are also classed as tonics.

This division includes substances used as foods.

IODINE.

IODUM.—Iodine. **Dose, 0.005 gm. = 5 milligm. ($\frac{1}{10}$ gr.).**

Preparations.

1. **Liquor Iodi Compositus.**—Compound Solution of Iodine. (Lugol's Solution.) **Dose, 0.2 c.c. (3 ♏).**
2. **Tinctura Iodi.**—Tincture of Iodine. **Dose, 0.1 c.c. (1½ ♏).**
3. **Unguentum Iodi.**—Iodine Ointment.

ACTION OF IODINE.

External.—Iodine is an **irritant, disinfectant,** and **parasiticide.** The first effect of its application to the skin is a yellowish or dark brown discoloration, which is removable by alkalies or sodium thiosulphate. It acts more slowly than most other irritants, but on account of its volatility and because it precipitates proteids and enters into easily dissociated compounds with them, its action is both penetrating and prolonged. It produces a sensation of heat and itching, accompanied by local hyperæmia and sometimes by more or less œdematous swelling. Some exudation of leucocytes takes place, and the strong absorbent action of iodine has been attributed to this. Unless used in very concentrated solution or in the solid form, which may cause vesication or even corrosion, its irritant action is comparatively mild. By repeated applications, however, it is possible to secure very pronounced counter-irritation without the production of a deep destruction of tissue. The superficial cuticle is usually destroyed, and the skin afterwards exfoliates. As a result of its local application, small quantities are absorbed. The subcutaneous injection of solutions of it causes intense pain and irritation. The inhalation of the vapor of iodine also gives rise to very considerable irritation; exciting sneezing, coughing and some dyspnœa, with smarting, swelling and increased secretion in the nasal mucous membrane, conjunctiva, throat and lower respiratory passages.

Internal.—Iodine naturally exerts its local irritant action on the gastro-intestinal tract, causing pain and vomiting, and sometimes purging. The drug may be recognized in the vomited matter and in the stools. In minute doses the slight irritation produced on the mucous membrane of the stomach may have a somewhat tonic effect, improving the appetite and digestion, and be followed by a sedative action. In excessive doses it produces marked irritation of the œsophagus and severe **gastro-enteritis**, but death is rarely caused by it. In fatal cases of poisoning the mucous membrane of the stomach and intestine has been found tumefied and loosened. The irritation of the alimentary canal may also prove fatal by inducing collapse and failure of the heart and respiration. In animals fatty degeneration of the heart, liver and kidneys has sometimes been found. Iodine, in the form of iodides and, it may be, in a combination with proteids, is rapidly absorbed by the mucous membranes generally. Its chief effects after absorption are due to its action on the **thyroid gland.** The symptoms produced by its continued administration, such as acceleration of the pulse and certain nervous phenomena, are much the same as those caused by large amounts of thyroid extract, and are thought to be probably due to the excessive production of the organic compound, iodothyrin. In the thyroid gland iodine exists normally in the form of this substance, and the administration of the drug may lead to an increase in its formation. Iodine is excreted, in the form of iodides, chiefly by the kidneys, but also to some extent in the saliva, perspiration, milk and bronchial secretion. Free iodine has been detected in the stomach, and this is believed to probably result from the decomposition of hydriodic acid excreted into that organ.

Therapeutics of Iodine.

External.—Iodine preparations are much relied upon as irritants, counter-irritants and resolvents. The tincture is one of the most popular of all external applications. While mild in its action, a sufficient effect may usually be secured by the repetition of its use. The ointment and compound solution are also comparatively mild preparations. "Iodine paint" is a tincture twice as strong as the official tincture. The conditions for which these preparations are used are almost innumerable, and need not be given in detail. Among them may be mentioned chronic inflammation of joints, periostitis, enlarged glands, buboes, abscesses, chilblains, pleurisy, and inflammation or retraction of the gums. For the last-named, what is known as dental tincture of iodine, consisting of tincture of iodine, 11, and alcohol, 30, is sometimes applied over a very circumscribed area. This, or the official tincture, may be painted over a spot of tinea or ringworm, and the tincture is usually efficacious in tinea versicolor. It is sometimes of service in lupus also, and is curative in lentigo and chloasma. Added to salt water, it forms a useful wash in chronic ozæna. Two preparations of iodine are fequently employed in the treatment of diseases of women, namely: Churchill's tincture; iodine, 5;

potassium iodide, 1; water, 8; alcohol, 24; and Battey's fluid: iodine, 2; pure phenol, 1. A colorless tincture of iodine has the advantage of not staining the skin, but is much milder than the ordinary tincture. In it iodine is dissolved in alcohol and decolorized by a strong solution of ammonia; but it really contains no iodine, ammonium iodide and iodate being formed, and any irritant affect which it may have is due to excess of ammonia. Formerly the practice was much in vogue of injecting tincture of iodine into the sac of hydrocele and into cysts, abscesses, dropsical joints, and the pleural cavity after empyema, as well as into other cavities for the relief of various affections, but other methods of treatment have largely superseded this. When it is employed, great caution must be observed, as intense pain and irritation may be caused, which may possibly be followed by collapse or by suppuration and gangrene. Fatal systemic poisoning has also been known to result from the injection of large quantities of iodine into cysts. The same objections hold true as regards the parenchymatous injection of the tincture in hypertrophied tonsil, goitre, glandular tumors, etc. In some cases of spina bifida a successful result may be obtained by the injection of Morton's fluid, which consists of iodine, 1; potassium iodide, 3; glycerin, 48.

Internal.—Among the ignorant the idea has long prevailed that seaweed has the effect of reducing obesity, and the *Fucus vesiculosis,* or bladderwrack, has been especially esteemed for this purpose. Consequently, it has been made the basis of various quack preparations, but any action it may have in this regard would seem to be due simply to the interference with nutrition caused by the digestive disturbances arising from the iodine, chlorine and bromine in its composition. .06 c.c. (1 m.) of tincture of iodine, largely diluted and repeated from time to time, may sometimes have the effect of arresting vomiting. Minute doses of the tincture or compound solution may also be of service in passive intestinal hemorrhage or diarrhœa from atony of the mucous membrane. Goitre, when there is present simply a hypertrophy of the gland elements, may not infrequently be successfully treated by the internal and external use of iodine. For the internal treatment the best mode of administration is to give the tincture in small doses with potassium iodide, freely diluted. Thyroid extract, however, is much more efficient. Iodine has been thought to have some curative influence in malarial fevers, but probably not much reliance is to be placed upon it. To increase its efficiency it has been advised that phenol should be combined with it. Thus, .60 c.c. (10 ♏), well diluted, of a mixture of the tincture with phenol, in the proportion of 8 to 1, may be prescribed three times a day; though, as this amount is large, its effects should be carefully watched. A similar combination has sometimes proved of service in typhoid fever: Tincture of iodine, 2; phenol, 1; dose, .06 to .18 c.c. (1 to 3 m.) three times a day. The compound solution has also been employed in typhoid fever. This preparation has obtained repute as a remedy in scrofulous affections of the skin and of the lymphatic glands, especially in syphilitic children, and is stated to be useful in some old syphilitic skin diseases attended by thickening and scaling. Judiciously employed, iodine preparations are of some value as inhalations. The vapor (tincture of iodine, 1; water, 8; to be gently heated) is sometimes prescribed for diseases of the lungs and air-passages, but it is too irritating. Camphor is also sometimes inhaled with tincture of iodine. In some cases of "hay asthma" the local application of the following with a post-nasal syringe is of advantage: tincture of iodine, 6; phenol, 1; water, 190. The inhalation of iodine and turpentine has been recommended, as an adjuvant to other methods of treatment, in laryngeal and pulmonary tuberculosis.

1. **POTASSII IODIDUM.**—Potassium Iodide. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

Preparations.

1. **Acidum Hydriodicum Dilutum.**—Diluted Hydriodic Acid. **Dose, 0.5 c.c. (8 ♏).**

2. **Liquor Iodi Compositus.**—Compound Solution of Iodine. **Dose, 0.2 c.c. (3 ♏).**

3. **Syrupus Acidi Hydriodici.**—Syrup of Hydriodic Acid. **Dose, 4 c.c. (1 fl. dr.).**

4. **Unguentum Potassii Iodidi.** — Ointment of Potassium Iodide.

2. **AMMONII IODIDUM.**—Ammonium Iodide. **Dose, 0.250 gm. = 250 milligm. (4 gr.).**

3. **SODII IODIDUM.**—Sodium Iodide. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

4. **STRONTII IODIDUM.**—Strontium Iodide. **Dose, 0.500 gm. = 500 milligm. (7½ gr.).**

5. **ZINCI IODIDUM.**—Zinc Iodide. **Dose, 0.065 gm. = 65 milligm. (1 gr.).**

ACTION OF THE IODIDES.

External.—None. Iodides in watery solution are not absorbed from the unbroken skin, but are rapidly absorbed from mucous membranes.

Internal.—The effects produced by the iodides appear to vary considerably, not only in different individuals, but also in the same individual at different times, and their mode of action is still a matter of great uncertainty. It is recognized, however, that they are capable of causing two distinct kinds of effects, one an irritation, in consequence of their salt-action, of the alimentary canal, manifested by nausea and vomiting and sometimes by diarrhœa, and the other a series of symptoms to which the name of iodism has been given. The latter symptoms may be elicited by considerably smaller doses than the gastric irritation, but, as a rule, appear only when the administration has been continued for some time, the length of this period varying greatly in different instances. The size of the dose naturally has some relation to their onset. When administered internally the iodides are absorbed unchanged by the stomach and intestine, and it is found that they make their appearance in the secretions within a very short time. They are excreted mainly in the urine, in which they are found as salts; also to some extent in the saliva and in various other secretions, as those of the nasal mucous membrane and sebaceous glands, and in the tears, sweat and milk. By the stomach small amounts are eliminated as hydriodic acid and sometimes as free iodine. No free iodine, however, has been found in the saliva, sweat or nasal secretion, and it is stated that no iodine can be detected in the breath of animals poisoned with iodides. There seems to be no question that some of the iodide undergoes decomposition in the body, and there is strong ground for believing that the symptoms of iodism are produced by the iodine thus set free. Support to this view is afforded by the fact that repeated doses of iodine sometimes cause symptoms resembling those of iodism, and also by the fact that formerly much the same therapeutic effects were produced by the internal administration of iodine which are now obtained with the iodides. As has been stated, free iodine is excreted into the stomach, and, furthermore, an organic compound of iodine has been found in the hair, muscles, heart, etc., after iodide treatment. Various explanations have been offered regarding the formation of free iodine from iodides, but as none of the theories advanced has as yet been positively demonstrated, they need not be given here. Some of the symptoms are thought to be probably due to action on the thyroid gland. The urine is generally increased by the iodides, although so far as known they have no specific action on the kidneys. On the other hand, the secretion of milk is diminished. Infants have been known to suffer with iodism from being nursed by persons under iodide treatment.

Iodism.—This is induced by all the iodides, and the basic ion does not appear to be concerned in the effect. Owing to the fact that iodine is more readily freed from it, ammonium iodide is said to be more liable than the others to cause iodism. The symptoms may be divided into two groups. (1) Very commonly there is catarrh of the respiratory passages, which commences in the nasal mucous membrane, exciting a profuse watery discharge, and extends both upward and downward. Accordingly there is conjunctivitis, and severe headache may result from the invasion of the frontal sinuses. At the same time there is much swelling and irritation about the fauces, the tonsils are liable to become inflamed, and laryngitis or bronchitis may result. Œdema of the larynx, which unless promptly relieved may prove fatal, occasionally occurs. In animals it has been shown that the bronchial secretion is increased by quite small quantities intravenously injected. Usually somewhat later, an eruption may appear upon the skin. This most commonly consists of erythematous patches, but instead there may be papules, which sometimes become pustular, and, more rarely, other forms of cutaneous disease. Œdema of the face is met with in some instances, and very rarely there is albuminuria. Nervous troubles, neuralgia, singing in the ears, convulsive movements, disturbed intellection, and rarely atrophy of the mammæ and testes may be noticed. (2) Iodic cachexia (which is characterized by rapid emaciation), severe cardiac palpitation, and ravenous appetite occasionally occur as late phenomena. The local manifestations of iodism can sometimes be prevented by the administration of alkalies, and hence it is thought that the variation of their extent in different persons, or in the same person at different times, may perhaps be explained by a different degree of acidity. Children appear to be less subject to iodism than adults. A tolerance may be established, and not infrequently the symptoms disappear while the administration is still being maintained. Although the manifestations may be very severe, a cessation begins soon after the treatment is discontinued, and the chewing of pellitory will hasten the elimination of iodine in the chronic forms. When iodic cachexia has supervened, however, the symptoms may not disappear for a considerable time.

THERAPEUTICS OF THE IODIDES.

The iodides were largely substituted for iodine in therapeutics for the reason that they are less irritating to the gastro-intestinal tract. Potassium iodide is the one in most general use. The most conspicuous of their applications is in the treatment of syphilis, in which their very great value has long been established. It is in the third stage of the disease that they produce results which cannot be accomplished by any other means; often causing the rapid absorption of nodes, gummata and other deposits. In order to secure the best effect it is necessary to give very large doses in many instances, so that 8, 12 or even 16 gm. (2 to 4 dr.) may be taken in a day. In syphilis of the nervous system large doses are especially called for, and daily amounts of 30 gm. (1 oz.) are not infrequently required in these cases. No symptoms of iodism are likely to appear until the disease subsides. What is known as the "mixed treatment" is often resorted to in syphilis, and it is believed by the majority of practitioners to be especially effective in the intermediate period, when the secondary stage is passing into the tertiary. This consists of the combination of potassium iodide with corrosive mercuric chloride; as a result, red mercuric iodide is formed and dissolved in the excess of potassium iodide. It has been suggested that in syphilis the iodides may act as a specific poison (antiseptic) to the unknown cause of the disease, but if this were so it seems reasonable to suppose that they would be much more efficacious in the early stages than is the case. Their remedial action remains in fact as yet unexplained. In various troubles not directly attributable to syphilis, but occurring in those who have at one time had the disease, iodides are often beneficial.

While these drugs are of little value in acute rheumatism, they are relied upon to some extent in chronic rheumatic manifestations. Rheumatoid arthritis would seem to be more amenable to the long-continued use of ferrous iodide than of the potassium salt, which is more commonly employed for its relief. In any affection in which the administration of the iodides must be maintained for a great length of time it will usually be found advantageous to allow occasional intermissions. In so-called gonorrhœal rheumatism the syrup of hydriodic acid is preferable to potassium or other iodide. In subacute catarrh of the duodenum and of the biliary ducts comparatively small doses of sodium or ammonium iodide may be of service, and it is asserted that the latter, especially when combined with arsenic, is one of the best remedies for the first stage of cirrhosis of the liver. Some good results with potassium iodide have been obtained in aneurism, but whether it has any effect in cases where there is no syphilitic taint seems doubtful. The iodides are not infrequently useful in promoting the absorption of inflammatory products, as, for instance, in joint disease, pleurisy and catarrhal and fibrinous pneumonia; and there is reason to believe that their prolonged use in sufficient dose may be of benefit in arteriosclerosis, interstitial nephritis, and amyloid disease of the kidney and other organs. Simple hypertrophy of the spleen may be cured by the internal use of the iodides and the external application of iodine paint or ointment of red mercuric oxide, and ammonium iodide is often efficacious in removing the enlargements of the spleen and liver caused by malarial disease. Iodides have long been employed in the treatment of goitre, but now seem likely to be entirely supplanted by thyroid extract. Ammonium iodide is highly esteemed in chronic bronchitis, and potassium iodide is sometimes quite efficacious in relieving the symptom asthma. For the internal treatment of "hay asthma" it should be given in full doses, and it may be advantageously combined with arsenic. The iodides have been recommended in various cerebral affections, but unless these are of syphilitic origin, not much is probably to be expected from their use. Potassium iodide is occasionally prescribed to diminish the secretion of milk. This salt is commonly given to promote the elimination of lead and mercury in cases of chronic poisoning from these metals, though experiments appear to indicate that it is not more efficient in this regard than the chloride or bromide. The iodide treatment is sometimes of service in non-syphilitic skin diseases. It is regarded as especially useful in actinomycosis and psoriasis. In many of the conditions in which potassium iodide is employed, particularly when the administration is long-continued, it would seem that sodium iodide should be preferred, as it does not occasion so much depression. Strontium iodide is used for the same purposes as the other iodides. It is believed that it is less likely to disturb the stomach, cause acne, and depress the heart than the remaining iodides. In many instances the syrup of hydriodic acid can be substituted with advantage for the iodides. It is not so likely to produce iodism, nor does it so readily give rise to the "iodide punishment." Its pleasant taste is grateful to most patients, and it should be administered, well diluted, one-half hour before meals, or at least upon an empty stomach. Some of the commercial preparations are likely to decompose readily, especially when made from tartaric acid and potassium iodide, and are objectionable from the amount of syrup which is administered when large doses are employed.

GOLD.

AURI ET SODII CHLORIDUM.—Gold and Sodium Chloride. **Dose, 0.005 gm. = 5 milligm. ($\frac{1}{10}$ gr.).**

Action of Gold and Sodium Chloride.

In small doses gold and sodium chloride is supposed to promote appetite and digestion, to stimulate the functions of the brain and to be an aphrodisiac. Full doses cause nausea and vomiting, and finally impair nutrition. The toxic symptoms resemble those of poisoning by corrosive mercuric chloride.

Therapeutics of Gold and Sodium Chloride.

It is useful in irritative dyspepsia, gastro-duodenal catarrh, hypochondriasis, and also chronic ovarian irritation and ovaritis, as well as in chronic albuminuria, hepatic sclerosis, and granular kidney, since it prevents hyperplasia of connective tissue. It is a valuable remedy in the tertiary manifestations of syphilis, especially of the bones, and presents fewer disadvantages than corrosive mercuric chloride.

GUAIAC.

GUAIACUM.—Guaiac. **Dose, 1 gm.; 15 gr.**

Preparations.

Tinctura Guaiaci.—Tincture of Guaiac. **Dose, 4 c.c. (1 fl. dr.).**

Tinctura Guaiaci Ammoniata.—Ammoniated Tincture of Guaiac. **Dose, 2 c.c. (30 ♏).**

Action of Guaiac.

External.—The tincture of guaiac is used for the detection of blood stains.

Internal.—Guaiacum is diaphoretic, expectorant and laxative, and in large doses a gastro-intestinal irritant, producing vomiting and purging. When it fails to act on the skin it is apt to cause free diuresis. In moderate amount it increases the flow of saliva and occasions a feeling of warmth in the epigastrium, and in its local effects on the stomach and reflex stimulation of the heart it resembles the volatile oils. It is thought to probably have a slight antiseptic action as regards the alimentary canal and the secretions, and when taken in small doses for some time is said to favorably affect metabolism. It is also considered to have emmenagogue properties. In some individuals a skin rash is produced by it.

THERAPEUTICS OF GUAIAC.

Internal.—Guaiacum is so disagreeable and its therapeutic value rests on such a slender basis that it is not very often prescribed. Its effectiveness in many chronic and obscure complaints, it has been observed, no doubt correctly, is due partly to its purgative property and partly to its nastiness, a quality which is highly appreciated by many patients. Probably its most useful application is in the treatment of tonsillitis, where in doses of 2 c.c. (½ fl. dr.) of the tincture, given in emulsion or yolk of egg every two hours, it often serves to abort the disease, or at all events to reduce the inflammation. In chronic sore-throat it is also sometimes of service, and, it is said, more particularly in patients who have had syphilis. The ammoniated tincture, diluted, may be employed as a gargle. On account of its purgative properties, guaiac has been given in habitual constipation. Malt extract is a good vehicle for it, or it may be prescribed in a pill in combination with other remedies. It is practically useless in syphilis and chronic rheumatism, for which it was at one time largely prescribed. It is thought by some to be of benefit in warding off attacks of gout. Doses of .75 gm. (12 gr.), taken in wafers and followed by effervescent lithium citiate, are recommended, and it is advised that the treatment should be maintained indefinitely.

PRICKLY ASH.

XANTHOXYLUM.—Xanthoxylum. (Prickly Ash Bark.) **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Xanthoxyli.—Fluidextract of Xanthoxylum. Dose, 2 c.c. (30 ♏).

Action of Prickly Ash Bark.

Xanthoxylum has about the same action as guaiac. It produces, when swallowed, a sensation of heat.

Therapeutics of Prickly Ash Bark.

It enjoys some reputation as a remedy for chronic rheumatism, and has been used in syphilis and chronic hepatic disorders. For patients suffering from chronic syphilis who do not tolerate either mercury or the iodides, McDade's formula may be employed. This is equal parts of the fluidextracts of sarsaparilla, stillingia, lappa, and phytolacca and of tincture of xanthoxylum. The dose is from 4 to 15 c.c.; 1 to 4 fl. dr., thrice daily. The bark, used as a masticatory, is a popular remedy for tooth-ache.

ICHTHYOL.

Ichthyol.—Ichthyol (unofficial). (Ammonium Ichthyolsulphonate.) **Dose, 0.60 to 1.20 gm.; 10 to 20 gr.**

Action of Ichthyol.

Ichthyol is an active reducing agent. It has some antiseptic property and it is mildly irritant to the skin, from which a certain amount of absorption takes place when it is rubbed in. In large doses it produces gastro-intestinal irritation. It is excreted by the kidneys and also, it is believed, by the intestine.

Therapeutics of Ichthyol.

It is used chiefly as a local application in skin diseases, especially chronic eczema and psoriasis. For acne rosacea, ichthyol paste is recommended (starch, 40; moisten with water, 20; rub in ichthyol, 40, and then a strong solution of albumin, 1 or more). In erysipelas in which it is thought to be of considerable service, an ointment composed of lanolin and ichthyol (20 to 50 per cent.) may be applied. Ichthyol has also been used for ulcers of the leg and for burns, and in the form of a suppository for chronic prostatitis. Combined with glycerin

(1 to 10) it is employed in gynæcological practice. It has been advised as an application over inflamed and rheumatic joints, indurated glands and swellings, as well as for chronic inflammations of the pelvic viscera, and is said to cause the absorption of inflammatory products. Internally it has been given in capsules or pills (in doses of .60 gm.; 10 gr.) for a variety of chronic affections, including rheumatism, syphilis and pulmonary disease, but it seems doubtful whether it is of any practical value.

SARSAPARILLA.

SARSAPARILLA.—Sarsaparilla. **Dose, 2 gm. (30 gr.).**

Preparations.

1. **Fluidextractum Sarsaparillæ.**—Fluidextract of Sarsaparilla. **Dose, 2 c.c. (30 ♏).**
2. **Fluidextractum Sarsaparillæ Compositum.**—Compound Fluidextract of Sarsaparilla. **Dose, 2 c.c. (30 ♏).**
3. **Syrupus Sarsaparillæ Compositus.**—Compound Syrup of Sarsaparilla. **Dose, 16 c.c. (4 fl. dr.).**

ACTION OF SARSAPARILLA.

Sarsaparilla is not known to have any physiological action.

THERAPEUTICS OF SARSAPARILLA.

It is apparently useful only as a vehicle. On account of its containing an acrid glucoside similar to saponin it should be administered with some care, as intestinal ulceration has been attributed to its prolonged use.

SASSAFRAS.

SASSAFRAS.—Sassafras. **Dose, 8 gm. (120 gr.).**

SASSAFRAS MEDULLA.—Sassafras Pith.

Preparation.

Mucilago Sassafras Medullæ.—Mucilage of Sassafras Pith. **Dose, 16 c.c. (4 fl. dr.).**

OLEUM SASSAFRAS.—Oil of Sassafras. **Dose, 0.2 c.c. (3 ♏).**

SAFROLUM.—Safrol. **Dose, 0.3 c.c. (5 ♏).**

ACTION OF SASSAFRAS.

Sassafras has the action of the volatile oils in general. The pith is demulcent.

Safrol, which also occurs in the oil of camphor and of cinnamon and in various barks, constitutes about 80 per cent. of the oil of sassafras, and its action is therefore practically the same as that of the latter.

THERAPEUTICS OF SASSAFRAS.

The mucilage is somewhat stimulant in its action, and is an excellent vehicle.

STILLINGIA.

STILLINGIA.—Stillingia. (Queen's Root.) **Dose, 2 c.c. (30 gr.).**

Preparation.

Fluidextractum Stillingiæ. — Fluidextract of Stillingia. **Dose, 2 c.c. (30 ♏).**

ACTION OF STILLINGIA.

Stillingia is in large doses emetic and cathartic, but in smaller ones, alterative.

THERAPEUTICS OF STILLINGIA.

It is a valuable remedy in syphilis and in the cutaneous and hepatic diseases which are benefited by so-called alterative medicines.

BURDOCK.

LAPPA.—Lappa. (Burdock.) **Dose, 2 gm. (30 gr.).**

Preparation.

Fluidextractum Lappæ.—Fluidextract of Lappa. **Dose, 2 c.c. (30 ♏).**

ACTION OF BURDOCK.

Burdock is considered to be a diaphoretic alterative.

THERAPEUTICS OF BURDOCK.

It has been recommended in the treatment of various chronic skin diseases, especially psoriasis and acne.

CHIMAPHILA.

CHIMAPHILA.—Chimaphila. (Pipsissewa.) **Dose, 2 c.c. (30 gr.).**

Preparation.

Fluidextractum Chimaphilæ.—Fluidextract of Chimaphila. **Dose, 2 c.c. (30 ♏).**

ACTION OF CHIMAPHILA.

This plant is believed to be diuretic and diaphoretic.

THERAPEUTICS OF CHIMAPHILA.

It is used for rheumatism and nephritic affections.

MARIGOLD.

CALENDULA.—Calendula. (Marigold.) **Dose, 1 gm. (15 gr.).**

Preparation.

Tinctura Calendulæ.—Tincture of Calendula.

ACTION OF MARIGOLD.

Marigold was formerly supposed to be antispasmodic and sudorific, but now it is believed to have no therapeutic value.

THERAPEUTICS OF MARIGOLD.

The tincture has been employed topically to promote the healing process in wounds, burns, ulcers, etc.

SCUTELLARIA.

SCUTELLARIA.—Scutellaria. (Skullcap.) **Dose, 1 gm. (15 gr.).**

Preparation.

Fluidextractum Scutellariæ.—Fluidextract of Scutellaria. **Dose, 1 c.c. (15 ♏).**

ACTION OF SCUTELLARIA.

Scutellaria is believed to be antispasmodic and alterative.

THERAPEUTICS OF SCUTELLARIA.

It is used as a nervous sedative in combination with other remedies.

COD LIVER OIL.

OLEUM MORRHUÆ.—Cod Liver Oil. (Oleum Jecoris Aselli.) **Dose, 16 c.c. (4 fl. dr.).**

Preparations.

1. **Emulsum Olei Morrhuæ.**—Emulsion of Cod Liver Oil. **Dose, 8 c.c. (2 fl. dr.).**
2. **Emulsum Olei Morrhuæ cum Hypophosphitibus.**—Emulsion of Cod Liver Oil with Hypophosphites. **Dose, 8 c.c. (2 fl. dr.).**

ACTION OF COD LIVER OIL.

External.—Cod liver oil is emollient to the skin, and, when rubbed in, is absorbed from it.

Internal. *Gastro-intestinal Tract.*—Cod liver oil, while often well borne by the stomach, has, especially in large doses, a tendency to cause eructations, nausea and sometimes diarrhœa. It is generally believed that it is more rapidly absorbed from the intestine than other oils, though the evidence on this point is not altogether conclusive. Some authorities attribute this supposed superior absorbability to the free acid in the oil, the presence of this facilitating saponification and emulsion. While this explanation might hold good as regards the old dark-colored oils, the pale oil now generally in use is found to often contain less free acid than ordinary olive oil. In the test-tube, at all events, cod liver oil forms an emulsion more rapidly than other oils.

Tissues.—Cod liver oil reduces the color of a solution of potassium permanganate more promptly than other oils, showing that it is more readily oxidized. As it is a fat which is readily absorbed and readily assimilated, its continued ingestion leads to a marked increase in weight and strength. It is thus a food of the highest value, and it is especially esteemed for the reason that many delicate persons who cannot digest ordinary animal fats are able to take this. In addition, there is some ground for supposing that cod liver oil, aside from its admirable qualities as a food, possesses certain peculiar virtues in consequence of special elements in its composition. Thus, if it is true, as has been stated, that iodine may occur in the proportion of 1 to 2,000 of the oil, the influence of this remedy is not to be ignored. Erythema or acne is sometimes caused by cod liver oil.

THERAPEUTICS OF COD LIVER OIL.

External.—The external application of cod liver oil by rubbing it into the skin is undoubtedly of considerable value in cases of defective nutrition or wasting disease, both in adults and children, but the very disagreeable odor of the oil is a serious objection to its use. In infants the common practice has been to apply it simply under the binder, but in order to prevent the child from smelling so much of the oil the following method is recommended: The patient is stripped and the oil applied over the surface of the body, with the manipulations of massage, before a warm fire; a blanket is wrapped around him and should be kept on for an hour or two; the excess of oil is then removed by a warm bath containing a little whiskey. Inunction with cod liver oil has sometimes been practised in the case of adults suffering from chronic dysentery or scaly skin diseases, and, when other treatment proves inadequate, it may be resorted to in children affected with chronic skin diseases, marasmus, tuberculosis and wasting diseases generally.

Internal.—Cod liver oil is of more value than any other one remedy in nearly all varieties of tuberculosis. The following conditions are regarded as contra-indicating its use: Diarrhœa, whether due to the disease or caused by the oil, severe hæmoptysis, vomiting, aggravated dyspepsia, and high temperature. When none of these is present, it is indicated in convalescence from acute disease, especially in children, and in all chronic diseases attended with malnutrition and loss of flesh. It was first introduced in medicine for the treatment of chronic rheumatic affections, and while not now so generally employed in these as formerly, it may not infrequently prove of service when they occur under bad hygienic influences in cachectic subjects. It is beneficial in strumous synovitis and in caries and necrosis of bone, and both its local and internal use has been commended in rheumatic gout with deposits about the joints. In diseases of the skin of strumous origin it has been designated "our sheet-anchor," and there is no question of its utility in tertiary syphilis, chronic bronchitis, emphysema, and various chronic affections of the brain and nervous system. It may constitute a very efficient element in the treatment of neuralgia, chorea, epilepsy, mercurial tremor, and paralysis agitans, and in atheroma of the arteries it has been found useful in combating degenerative changes and preventing failure in the nutrition of the brain. Here its prolonged administration with phosphates or hypophosphites is commended. Cod liver oil is invaluable in the treatment of rickets and the wasting diseases of children, and in these conditions it may often be given with advantage in association with syrup of ferrous iodide. Many infants and young children take the undisguised oil with avidity. Older persons, however, are apt to object to its unpleasant odor and taste. When such objection is made, the oil may be administered in soft capsules or in one of the numerous carefully compounded preparations to be found on the market. Some patients are able to take the oil by rinsing out the mouth with whiskey or brandy beforehand, and others by putting a little salt in the mouth after swallowing it. To render it less unpalatable .60 c.c. (10 ♏) of pure ether or .12 c.c. (2 ♏) of oil of peppermint or cloves may be added to each dose. One part of essential oil of eucalyptus to 100 parts of pale oil is said to entirely do away with the odor and taste. A very nutritious combination in which the taste of the oil is quite well disguised is made by rubbing together equal parts of cod liver oil and extract of malt. In this, however, the oil is likely to repeat. Paresi's well-known disguise is prepared as follows: To 400 parts of cod liver oil are added 10 parts of animal charcoal and 20 parts of ground roasted coffee. The mixture is digested in a water-bath at a temperature of 50° to 60° C. (122° to 140° F.), and after standing for three days is filtered and put into well-stoppered bottles. The oil is also sometimes given in ordinary black coffee. The most popular way of taking it is in the form of emulsions, and a great variety of these have been suggested. The following is advised by the British Pharmaceutical Conference: Cod liver oil, 128; the yolk of two eggs; tragacanth in powder, 1; elixir of saccharin, 8; tincture of benzoin, 8; spirit of chloroform, 8; oil of bitter almonds, 1; distilled water to 256. (The elixir of saccharin consists of saccharin, 2; sodium bicarbonate, 1; alcohol, 5; distilled water, 35.)

When, as is often the case, it is desirable to give iron with cod liver oil, the following may be used: Cod liver oil, 960; iron and ammonium citrate, 20; potassium carbonate, 12; saccharin, 1; oil of caraway, 1; water to 1920. The hypophosphites are also sometimes incorporated in emulsions of the oil. It will be seen that emulsions of the oil, with and without hypophosphites, are now official preparations.

DIVISION XV.—DRUGS WHICH HAVE NO MARKED THERAPEUTIC PROPERTIES.

All of the drugs here presented are official and most of them are in daily use in the pharmacies. Their interest to the physician lies chiefly in their employment to make prescriptions more palatable or sightly.

VANILLA.

VANILLA.—Vanilla. **Dose, 1 gm. (15 gr.).**

Preparation.

Tinctura Vanillæ.—Tincture of Vanilla.

VANILLINUM.—Vanillin. **Dose, 0.030 gm. = 30 milligm. (1/2 gr.).**

ACTION OF VANILLA.

Vanillin has been asserted to be locally irritant and to have produced in frogs spinal convulsions, followed by paralysis affecting both the spinal cord and the motor nerves. Vanilla is probably inert as regards any action on the human system. There can be little question that the cases of poisoning which from time to time have been reported from the eating of ice-cream and other articles flavored with vanilla were due to ptomaines.

THERAPEUTICS OF VANILLA.

Vanilla has been suggested as a remedy in hysteria, but it is used for the most part simply as a flavoring agent.

COCHINEAL.

COCCUS.—Cochineal.

ACTION OF COCHINEAL.

It has been supposed by some to possess anodyne properties, but it probably has no action.

THERAPEUTICS OF COCHINEAL.

Cochineal is used only as a coloring agent. It was formerly employed in the treatment of whooping-cough (in which it had a considerable vogue), and of neuralgia.

RED SAUNDERS.

SANTALUM RUBRUM.—Red Saunders.

ACTION OF RED SAUNDERS.

Red Saunders is of no value medicinally.

THERAPEUTICS OF RED SAUNDERS.

It is used only as a coloring agent.

WAX.

CERA FLAVA.—Yellow Wax.

CERA ALBA.—White Wax.

ACTION OF WAX.

Wax has no medicinal qualities.

THERAPEUTICS OF WAX.

Yellow and white wax are used only as bases for various plasters, cerates and ointments.

PARAFFIN.

PARAFFINUM.—Paraffin.

ACTION OF PARAFFIN.

None.

THERAPEUTICS OF PARAFFIN.

It makes a good basis for ointments used for protecting wounds or sores, but as it is absorbed with difficulty, it is not suitable for ointments to be applied in cases in which the absorption of drugs is desired. In recent years subcutaneous injections of paraffin have been largely and successfully employed for the correction of deformities, especially of the nose.

SUET.

SEVUM PRÆPARATUM.—Prepared Suet.

ACTION OF SUET.

Suet has the action of fats in general.

THERAPEUTICS OF SUET.

Suet is used chiefly in the preparation of cerates.

LYCOPODIUM.

LYCOPODIUM.—Lycopodium. (Vegetable Sulphur.)

ACTION OF LYCOPODIUM.

The plant was formerly regarded as diuretic and antispasmodic, but it probably has no physiological action. Lycopodium powder has a pronounced property of absorbing oils and oleoresins.

THERAPEUTICS OF LYCOPODIUM.

It makes an excellent absorbent and protective powder when dusted over an excoriated surface, as in the intertrigo of infants. For this purpose it is often mixed with an equal quantity of powdered starch. It is also used as a basis for insufflations. As it is powerfully repellent to water, and thus protects hygroscopic substances, it is a good basis for pills, and it is extensively employed for facilitating the rolling of the pilular mass and preventing the adhesion of pills to each other.

PETROLEUM BENZIN.

BENZINUM.—Petroleum Benzin.

Preparation.

Benzinum Purification.—Purified Petroleum Benzin.

ACTION OF PETROLEUM BENZIN.

Large doses give rise to gastro-enteritis, and poisoning may be induced by its inhalation.

THERAPEUTICS OF PETROLEUM BENZIN.

Benzin is used in the manufacture of volatile oils and for depriving powdered drugs of their fixed oil by percolation, as a substitute for ether in making oleoresins, and for dissolving fats, resins, caoutchouc and some of the alkaloids. It has occasionally been employed externally in the treatment of neuralgia, rheumatic pains, scabies and prurigo, and internally as a remedy for tapeworm.

CARBON DISULPHIDE.

CARBONEI DISULPHIDUM.—Carbon Disulphide. (Carbon Bisulphide.)

ACTION OF CARBON DISULPHIDE.

Persons exposed to its fumes in the arts are liable to become emaciated and to be affected with headache, vertigo, nervous excitement, incoördination of movement, and depression of the special senses, with impairment of sensation and motility. Even insanity is said to sometimes result. Directly inhaled, it excites violent coughing and produces general anæsthesia with marked muscular rigidity. It is a powerful cardiac depressant, and even in small doses by the mouth causes severe nausea and vomiting, with a burning sensation in the epigastrium, and a weak and rapid action of the heart.

THERAPEUTICS OF CARBON DISULPHIDE.

Carbon disulphide is used as a solvent for rubber and similar bodies. It can be freed from its usual disgusting odor by repeated rectification. In minute doses it is said to relieve gastralgia and the pain of cancer of the stomach, as well as nausea and vomiting.

ACETONE.

ACETONUM.—Acetone.

ACTION OF ACETONE.

It is stated to possess anæsthetic, hypnotic and anthelmintic properties.

THERAPEUTICS OF ACETONE.

It has been given in rheumatism and gout, but its principal use is in pharmacy. It is employed as a solvent for resins, fats, camphors, gun-cotton, etc.

MASTIC.

MASTICHE.—Mastic. **Dose, 2 gm.; 30 gr.**

Preparation.

Pilulæ Alœs et Mastiches.—Pills of Aloes and Mastic. **Dose, 2 pills.**

ACTION OF MASTIC.

Mastic is said to be a mild stimulant.

THERAPEUTICS OF MASTIC.

It is mostly used as a masticatory, and for cements and varnishes.

RUBBER.

ELASTICA.—Rubber. (India-rubber. Caoutchouc.)

ACTION OF RUBBER.

It is so insoluble that it cannot be absorbed in any form into the blood. It therefore has no action on the system.

THERAPEUTICS OF RUBBER.

Rubber is used for making plasters, bougies, pessaries, and syringes.

TALC.

TALCUM.—Talc.

Preparation.

Talcum Purificatum.—Purified Talc.

ACTION OF TALC.

None.

Therapeutics of Talc.

Purified talc makes an excellent filtering basis, and it is employed in the manufacture of a large number of official pharmaceutical preparations. As a dusting-powder it is useful in prickly heat (*lichen æstivus*) and other pruritic eruptions.

DRIED CALCIUM SULPHATE.

CALCII SULPHAS EXSICCATUS.—Dried Calcium Sulphate. (Dried Gypsum. Plaster of Paris.)

Action of Dried Calcium Sulphate.

Dried calcium sulphate is inert.

Therapeutics of Dried Calcium Sulphate.

It is used for making casts of deformities and injuries, and for making bandages and apparatus for injuries and diseases when immobilization is necessary.

INDEX, GENERAL AND THERAPEUTIC.

In all Latin titles of more than one syllable, the accented syllable is distinguished by the sign ′ placed after the corresponding vowel.

A. B. C. liniment, 285
Abortion, Threatened
    opium, 741
    viburnum, 803
Abrasions. *See* Wounds
Abscess
    formaldehyde, 48
    phenol, 59
    iodoform, 69
    sulphurated lime, 91
    sulphurous acid, 93
    balsam of Peru, 100, 597
    arnica, 342
    poultices, 406, 411, 425
    castor oil, 597
    menthol, 653
    orthoform, 663
    belladonna, 699
    iodine, 829
Absorbent cotton, 409
Aca′cia, 425
Accelerating centre, drugs acting on, 230, 295
A. C. E. mixture, 773
Acetanilide, 493
Acetone, 849
    chloroform, 756
Acetphenetidin, 500
Acetyl paramidophenol salicylate, 634
Acid, acetic, 302
    arsenous, 212
    benzoic, 479
    boric, 15, 73
    bromic, 690
    cacodylic, 213, 223
    camphoric, 270
    carbolic, 52
    cathartic, 604
    chromic, 315
    citric, 302
    chrysophanic, 107, 601
    di-iodosalicylic, 66, 73
    ethylsulphonic, 758
    gallic, 364
    glycuronic, 56, 482, 751
    hippuric, 481
    hydriodic, 831
    hydrobromic, 691
    hydrochloric, 302
    hydrocyanic, 506
    hypophosphorous, 789
    lactic, 303
    muriatic, 302
    nitric, 301
    nitrohydrochloric, 302
    nitromuriatic, 302
    oleic, 416
    orthocreosotic, 627, 632
    phosphoric, 302
    prussic, 506
    salicylic, 625
    salicyluric, 626, 628, 632
    sarcolactic, 787
    sphacelic, 792
    stearic, 406
    sulphuric, 301
    sulphurous, 15, 91
    tannic, 358
    tartaric, 303
    trichloracetic, 302
    urochloralic, 751
    xanthoproteic, 303
Acids, 301
Acids, Poisoning by, 315
Acne
    formaldehyde, 48
    sulphur, 87, 88
    sulphur iodide, 91
    sulphurated lime, 91
    thymol, 97
    chrysarobin, 111
    potassium hydroxide, 143
    arsenic, 222
    nitric acid, 307, 313
    nitrohydrochloric acid, 313
    oil of rosemary, 340
    witchhazel, 372
    copper sulphate, 398
    soft soap, 419
    glycerin, 434
    quillaja, 525
    bismuth, 589
    hydrastis, 798
    ichthyol, 839
    burdock, 841
Aconine, 284
Aconite, 279
Aconite Poisoning, 288
Aconitine, 279
Acromegaly
    pituitary extract, 824
Actions, pharmacological and therapeutical, 8
Actol, 384, 387
A′deps, 407
    la′næ, 406
        hydro′sus, 406
Addison's Disease
    glycerophosphates, 791
    suprarenal extract, 821

- **Adenitis.** *See* Lymphadenitis.
- Adhesive plaster, 374
- Administration of drugs, 2, 6
- Adonidin, 253
- Adrenalin, 819
- **Adynamia in Fevers, etc.** *See* Collapse
- Æsculap water, 164, 547
- Æ'ther, 778
  - ace'ticus, 782
- Æthy'lis ca'rbamas, 762
  - chlo'ridum, 664
- **After-pains**
  - camphor, 277
  - morphine, 277, 741
  - gelsemium, 682
- Air inhaled, drugs altering composition of, 501
- Aix-la-Chapelle, 90
- A'lcohol, 711
  - ethylic, 711
  - trichlor-tertiary butyl, 756
- **Alcoholism**
  - quinine, 132
  - ammonia, 184, 186
  - ammonium chloride, 186
  - arsenic, 219, 671
  - digitalis, 245
  - alcohol, 265, 722
  - camphor, 277
  - veratrum, 292
  - zinc oxide, 395
  - piperin, 395
  - myristica, 562
  - capsicum, 575, 763, 772
  - cocaine, 658
  - nux vomica, 671
  - bromides, 688, 753
  - atropine, 703
  - hyoscine, 709
  - morphine, 741
  - hydrated chloral, 741, 753
  - paraldehyde, 762
  - lupulin, 763
  - chloroform, 772
  - phosphorus, 786
  - hydrastis, 799
- Aldehyde, cinnamic, 563
  - salicylic, 626
- Ale, 763
- Allspice, 561
- Almond, 427
- Aloes, 597
- Aloin, 597
- **Alopecia**
  - sulphur, 87
  - thymol, 97
  - chrysarobin, 112
  - arsenic, 222
  - veratrine, 294
  - oil of turpentine, 322
  - oil of cajuput, 334
  - oil of eucalyptus, 338
  - cantharides, 341, 474
  - rosemary, 341, 475
  - pilocarpine, 444
  - quinine, 444
  - glacial acetic acid, 475
  - quillaja, 524
  - capsicum, 575
  - castor oil, 597
  - resorcinol, 625
  - alcohol, 722
- Alpha-eucaine hydrochloride, 659
- Alteratives, 827
- Althæ'a, 435
- Alum, 400
  - ammonia-ferric, 201
  - whey, 403
- Aluminum salts, 400
- Alumnol, 400, 402
- **Amenorrhœa**
  - boric acid, 78
  - potassium permanganate, 81
  - ammonia, 181
  - aconite, 287
  - mustard, 334, 463
  - cantharides, 476
  - fennel, 568
  - iron, 586
  - aloes, 586
  - myrrh, 586
  - strychnine, 672
  - ergot, 796
  - manganese dioxide, 802
  - apiol, 802
  - thyroid extract, 818
  - ovarian extract, 825
- Ammonia, solutions of, 176
  - spirit of, 176
- Ammonium, 176
  - acetate, 187
  - benzoate, 479
  - bromide, 683
  - carbonate, 183
  - chloride, 185
  - ichthyolsulphonate, 839
  - iodide, 832
  - muriate, 185
  - salicylate, 625
  - valerate, 581
- Amy'gdala ama'ra, 427
  - du'lcis, 428
- Amyl nitrite, 343
- A'mylum, 436
- **Anæmia**
  - iron salts, 209, 212
  - red wines, 210
  - arsenic, 220
  - potassium dichromate (pernicious), 318
  - copper sulphate, 398
  - oxygen, 533
  - calumba, 555
  - glycerophosphates, 791
  - thymus extract (pernicious), 823
- Anæsthesia, medullary, 658
- Anæsthetics, general, 643, 765
  - local, 636
  - dangers of, 642
- Anaphrodisiacs, 783
- Anarcotine, 749
- **Aneurism**
  - calcium chloride, 200
  - aconite, 287
  - veratrum, 292
  - morphine, 739
  - ergot, 796
  - potassium iodide, 835
- **Angina Pectoris**
  - arsenic, 221
  - cactus, 296

  - amyl nitrite, 346
  - nitroglycerin, 352, 353
  - erythrol nitrate, 357
- Anhidrotics, 439
- **Anidrosis**
  - oil of eucalyptus, 338
- Anise, 566
- **Ankylostomiasis.** *See* Uncinariasis.
- Anodynes, local, 636
- Anthelmintics, 16, 17, 101
- A'nthemis, 568
- Anthracene purgatives, 604
- **Anthrax**
  - phenol, 57, 60
  - iodoform, 70
  - sulphurated lime, 91
  - witchhazel, 372
  - ipecac, 519
  - menthol, 653
  - belladonna, 699
- Anticholagogues, 552
- Anticholera serum, 811
- Antidiphtheric serum, 804
- Antidote, arsenical, 201
  - hydrophobia, 814
- Anti-emetics, 543
- Antifebrin, 493
- Antigalactagogues, 785
- Antihidrotics, 439
- Antilithics, 455
- Antimony and potassium tartrate, 446
  - salts, 446
- **Antimony Poisoning**, 450
- Antiparasitics, 17
- Antiperiodics, 17
- Antiplague serum, 810
- Antipneumococcic serum, 809
- Antipyretics, 490, 493
- Antipyrine, 498
  - dimethylamido, 498
  - salicylate, 498
- Antiseptics, 14, 18
  - gastric, 538
  - internal, 16
  - intestinal, 548, 623
- Antisialogogues, 534, 535
- Antispasmodics, 504, 530
- Antistreptococcic serum, 808
- Antitetanic serum, 806
- Antitoxin, diphtheria, 804
  - tetanus, 806
- Antitoxins and serums, 803
- Antityphoid serum, 812
- Antivenomous serum, 810
- Antizymotics, 16
- **Anus, Fissure of**
  - iodoform, 69
  - sulphur, 88
  - caustic potash, 143
  - tannic acid, 362
  - iodo-tannin, 362
  - krameria, 369
  - witchhazel, 372
  - geranium, 373
  - flaxseed, 412
  - olive oil, 415
  - copaiba, 486
  - cocaine, 657
  - belladonna, 699
  - stramonium, 707
  - ergot, 799
  - hydrastis, 799
- Apenta water, 164, 547
- Aphrodisiacs, 783, 785
- **Aphthæ**
  - phenol, 58
  - borax, 77
  - honey, 77
  - sodium sulphite, 89
  - potassium chlorate, 156
  - sodium bicarbonate, 161
  - rhus glabra, 373
  - saccharin, 490
  - myrrh, 585
  - bismuth, 589
  - salicylic acid, 630
  - hydrastis, 798
- Apiol, 802
- Apo'cynum, 470
- Apomorphine, 513
- **Apoplexy, cerebral**
  - croton oil, 618
- A'qua, 458
  - destilla'ta, 458
  - hydroge'nii dio'xidi, 82
- Argonin, 384, 387
- Argyria, 385
- Argyrol, 384, 388
- Aristol, 98
- A'rnica, 341
- Arsenic, 212
  - antidote, 192, 201
- **Arsenic Poisoning**, 225
- **Arteriosclerosis**
  - nitroglycerin, 352
  - thyroid extract, 818
  - iodides, 835
  - cod liver oil, 845
- **Arthritis**
  - colloidal mercury, 39
  - phenol, 59
  - arsenic, 221
  - blisters, 474
  - iodides, 835
  - ichthyol, 840
- **Arthritis, Rheumatoid**
  - ferrous iodide, 211, 835
  - cod liver oil, 844
- Asafetida, 583
- **Ascites.** *See* Dropsy.
- Ash, prickly, 838
- Aspi'dium, 101
- **Asthma**
  - quinine, 133
  - potassium nitrate, 153
  - aconite, 287
  - amyl nitrite, 350
  - nitroglycerin, 352
  - spirit of nitrous ether, 356
  - alum, 403
  - pilocarpine, 445
  - sabal, 468
  - cubeb, 488
  - hydrocyanic acid, 510
  - grindelia, 531
  - lobelia, 531, 707
  - stramonium, 531, 706
  - menthol, 653
  - calabar bean, 679
  - gelsemium, 682
  - belladonna, 702
  - cannabis indica, 707
  - paraldehyde, 762
  - ether, 781
  - suprarenal extract, 821
  - potassium iodide, 836

- Astringents, 290
  - intestinal, 549
- Atropine, 692
  - and morphine, 705
- Aura'ntii ama'ri co'rtex, 570
  - du'lcis co'rtex, 570
- Au'ri et so'dii chlo'ridum, 837

- BAKERS' ammonia, 183
- Baking soda, 161
- Balsam of fir, 325
  - Friar's, 479
- Ba'lsamum Peruvia'num, 99
  - Toluta'num, 526
- Baltimore liniment, 285
- Barberry, 557
- Barium salts, 404
- Bark, cotton root, 797
  - cramp, 802
  - Panama, 524
  - Peruvian, 115
  - prickly ash, 838
  - sacred, 602
  - sassy, 268
  - slippery elm, 425
  - soap, 524
- Basham's mixture, 211
- Basilicon ointment, 330
- Baths, cold, hot, etc., 458
  - in fever, 460
- Battey's fluid, 830
- Bearberry, 466
- **Bed-sores**
  - lead plaster, 379
  - silver nitrate, 385
  - alum, 402, 722
  - soap plaster, 418
  - glycerin, 433
  - alcohol, 722
- Bellado'nna, 692
- Benzaconine, 283
- Benzaldehyde, 428
- Benzin, petroleum, 848
- Benzoates, 479
- Benzoin, 479
- Benzoinated lard, 407
- Benzosulphinide, 489
- Berberine, 797
- Be'rberis, 557
- Beta-eucaine, 661
- Betanaphthol, 623
- Be'tula, oil of, 632
- Bile, drugs acting on, 555
- **Biliousness**
  - calomel, 33, 602
  - blue mass, 33
  - sodium phosphate, 34
  - magnesium sulphate, 34, 192
  - ammonium chloride, 186
  - rhubarb, 602
  - podophyllin, 609
- Bismuth, 586
- **Bites, Insect and Snake**
  - chlorinated soda, 51
  - chlorinated lime, 51
  - potassium permanganate, 81, 82
  - caustic potash, 142
  - ammonia, 181, 182
  - olive oil, 414
  - alcohol, 519
  - ether, 519
  - ipecac, 519
  - pennyroyal, 568
  - antivenomous serum, 810
- Bitter apple, 613
- Bitters, 537, 553
- Bladder, drugs acting on, 458
- Bladderwrack, 830
- Blackberry, 374
- Black cohosh, 800
  - draught, 604
  - drop, 728
  - haw, 802
  - manganese oxide, 801
  - mustard, 331
  - pepper, 572
  - snakeroot, 800
  - wash, 20
- Blaud's pills, 200
- Bleaching powder, 49
- **Blepharitis**
  - citrine ointment, 32
  - yellow mercuric oxide, 32
  - formaldehyde, 48
  - hydrogen dioxide, 83
  - starch poultice, 437
  - ergot, 796
- Bliss's cure, 707
- Blistering collodion, 409
- Blisters, 472, 474
- Blood, drugs acting on, 133
- Bloodroot, 527
- Blue Lick Springs, 91
  - mass, 18
  - methylene, 764
  - stone, 396
  - vitriol, 396
- **Boils.** *See* Furuncle.
- Boneset, 451
- Borax, 74
- Boro-glycerin, 74
- Bougies, 4
- Bourboule water, 210, 223
- Brain, drugs acting on, 639
- Brandy, 711
- Brayera, 103
- **Bright's Disease.** *See* Nephritis.
- Bromides, 683
  - comparative action of the, 686
- **Bromidrosis.** *See also* Hyperidrosis
  - potassium permanganate, 80
  - oil of eucalyptus, 337
  - copper sulphate, 398
  - salicylic acid, 630
  - atropine, 701
  - hydrated chloral, 752
- Bromine, 682
- Bromism, 690
- Bromoform, 777
- Bronchial secretion, drugs affecting, 504, 513
  - vessels, drugs acting on, 505
  - spasm, drugs relaxing, 504
- **Bronchiectasis**
  - menthol, 653
  - guaiacol, 653
  - olive oil, 653
- **Bronchitis**
  - formaldehyde, 48
  - sodium sulphite (fetid), 90

  - sodium thiosulphate (fetid), 90
  - sulphurous acid (fetid), 93
  - thymol, 97
  - oil of thyme, 99
  - potassium bicarbonate, 146
  - potassium acetate, 149
  - potassium citrate, 149
  - ammonium carbonate, 184
  - ammonium chloride, 186
  - calcium chloride, 200
  - arsenic, 221
  - digitalis, 245
  - squill, 256, 702
  - camphor, 276
  - aconite, 285
  - nitric acid, 313
  - potassium dichromate, 318
  - oil of turpentine, 321, 324
  - oil of pine, 324, 326
  - Canada turpentine, 325
  - tar, 328, 329
  - rosin, 331
  - mustard, 332, 333, 334
  - oil of cajuput, 335
  - oil of eucalyptus, 338, 339
  - spirit of nitrous ether, 356
  - gallic acid, 365
  - lead acetate, 381
  - alum, 403, 404
  - petrolatum, 409
  - flaxseed, 412
  - licorice, 424, 426
  - acacia, 426
  - tartar emetic, 449
  - hot vapor bath, 463
  - buchu, 466
  - sabal, 468
  - benzoin, 484, 527
  - copaiba, 486
  - cubeb, 488
  - oil of santal, 489
  - hydrocyanic acid, 510
  - wild cherry, 513
  - apomorphine, 516
  - cocillaña, 516
  - ipecac, 519, 520
  - senega, 524
  - quillaja, 525
  - terebene, 525
  - terpin hydrate, 526
  - syrup of tolu, 526, 702
  - storax, 527
  - sanguinaria, 527
  - grindelia, 531
  - eriodictyon, 522
  - serpentaria, 558
  - anise, 567
  - myrrh, 586
  - cerium oxalate, 591
  - lobelia, 651
  - strychnine, 671
  - calabar bean, 679
  - gelsemium, 682
  - belladonna, 702
  - glycerin, 702
  - opium, 740
  - suprarenal extract, 821
  - ammonium iodide, 836
  - cod liver oil, 844
- **Broncho-pneumonia.** *See also* Bronchitis
  - Ammonium carbonate, 184
- Broom, 464
- Brown mixture, 424
- **Bruises.** *See* Contusions
- **Bubo**
  - iodoform, 70
  - silver nitrate, 386
  - iodine, 829
- Buchu, 465
- Buckthorn, 606
- **Bunions.** *See also* Corns
  - caustic potash, 143
- Burdock, 841
- Burnett's fluid, 393
- **Burns**
  - phenol, 57, 394, 432
  - boric acid, 77, 589
  - hydrogen dioxide (gun-powder), 83
  - thymol, 97
  - balsam of Peru, 100, 597
  - castor oil, 100, 597
  - sodium bicarbonate, 161, 432
  - ammonia, 181
  - Carron oil, 197, 412
  - oil of turpentine, 322
  - rosin cerate, 330
  - tannic acid, 361
  - witchhazel, 372, 432
  - lead salts, 379, 408
  - silver, 386
  - zinc oxide, 394
  - lanolin, 407, 589
  - lime water, 408, 432
  - collodion, 410
  - flaxseed, 412
  - olive oil, 413
  - soapsuds, 418
  - acacia, 426
  - glycerin, 432
  - bismuth, 432, 589
  - terebene, 525
  - grindelia, 531
  - orthoform, 663
  - opium, 743
  - chloroform, 772
  - gutta percha, 772
  - ichthyol, 839
  - calendula, 841
- Burton's line, 376
- Butter of antimony, 449
  - of cacao, 410
  - of zinc, 391
- Byne, 420

- CACAO butter, 410
- Cacodylic acid, 213, 223
- Ca'ctus, 295
- Cade, oil of, 329
- Caffeine, 257
- Cajuput, oil of, 334
- Calabar bean, 675
- Ca'lamus, 557
- Calcium, 194
  - bromide, 683
  - carbonate, precipitated, 194
  - chloride, 189
  - glycerophosphate, 790
  - hydroxide, 196

- Calcium hypophosphite, 789
  - lacto-phosphate, syrup of, 198
  - oxide, 196
  - phosphate precipitated, 198
  - sulphate, dried, 851
  - sulphide, crude, 90
- **Calculus, Biliary**
  - potassium bicarbonate, 146
  - sodium sulphate, 165
  - sodium phosphate, 165
  - Carlsbad waters, 166
  - oil of turpentine, 323
  - ether, 323
  - morphine, 324, 739
  - hydrated chloral, 324
  - nitroglycerin, 352
  - olive oil, 415
  - sodium benzoate, 416
  - sodium salicylate, 416, 632
  - glycerin, 434, 632
  - gelsemium, 682
  - belladonna, 703
  - chloroform, 773
- **Calculus, Renal**
  - potassium acetate, 147
  - potassium citrate, 147
  - glycerin, 434
  - belladonna, 703
  - morphine, 739
  - chloroform, 773
- **Calculus, Vesical.** *See also* Cystitis
  - lithium salts, 190
  - calcium carbonate, 195
  - buchu, 465
  - benzoates, 483
  - belladonna, 703
- Cale'ndula, 842
- Calomel, 19
- Calu'mba, 553
- Calx, 196
  - chlorina'ta, 49
  - sulphura'ta, 90
- Cambo'gia, 612
- Camphor, 270
  - preparations of, 270
- Canada balsam, 325
  - turpentine, 325
- Canadian hemp, 470
- **Cancer**
  - phenol, 58
  - iodoform, 70
  - potassium permanganate, 80
  - caustic potash, 142
  - arsenic, 222
  - chromium trioxide, 317
  - eucalyptus, 338
  - trypsin, 580
  - naphthalene, 624
  - belladonna, 699
  - cocaine, 699
  - stramonium, 707
  - codeine, 748
- **Cancer of the Stomach**
  - sodium chlorate, 175
  - arsenic, 219
  - orthoform, 664
  - morphine, 737
  - silver salts, 737
  - zinc salts, 737
  - bismuth, 737
  - carbon disulphide, 849
- **Cancer of the Uterus**
  - eucalyptus, 338
  - tannic acid, 361
  - phenol, 361
  - zinc chloride, 393
  - hydrated chloral, 752
  - mammary extract, 824
- **Cancrum Oris**
  - nitric acid, 307
- Ca'nnabis i'ndica, 725
- Canquoin's paste, 393
- Cantharidal collodion, 409, 472
- Cantha'rides, 472
- Caoutchouc, 850
- Ca'psicum, 574
- Caraway, 568
- Carbamate, ethyl, 762
- Ca'rbo anima'lis, 93
  - li'gni, 93
- Carbolic acid, 15, 52
- **Carbon Dioxide poisoning**
  - sodium chloride, 172
  - ammonia, 182
- Carbon disulphide, 849
- Carbuncle. *See* Anthrax
- Cardamom, 577
- Cardiac mechanism, drugs acting on, 226
- Carlsbad water, 164
- Carminatives, 540, 581
- Carolina pink, 109
- Carragheen, 434
- Carron oil, 196, 412
- Ca'rum, 568
- Caryo'phyllus, 559
- Casca'ra sagra'da, 602
- Ca'ssia fi'stula, 594
  - purging, 594
- Castile soap, white, 416
- Castor oil, 594
- Catapla'sma kaoli'ni, 405
- **Catarrh, Nasal**
  - phenol, 59
  - quinine, 133, 276
  - sodium chloride, 171
  - arsenic, 221
  - camphor, 275, 276
  - menthol, 275
  - belladonna, 276, 702
  - aconite, 285
  - oil of pine, 326
  - tannic acid, 360, 361
  - tannigen, 364
  - witchhazel, 372
  - alum, 402
  - petrolatum, 409
  - acacia, 427
  - bismuth, 427, 657
  - morphine, 427, 657
  - glycerin, 432
  - creosote, 432
  - oil of peppermint, 432
  - eupatorium, 451
  - cubeb, 488
  - pyrethrum, 574
  - bismuth, 589
  - cocaine, 657
  - alcohol, 721
  - Dover's powder, 740, 743
  - hydrastis, 798
- Cathartics, 548
- **Caustic Alkalies, Poisoning by,** 159

Caustic, lunar, 383
  mitigated, 383
  potash, 137
  soda, 158
  Vienna, 137
Caustics, 298
Cephaëline, 521
Ce'ra a'lba, 847
  fla'va, 847
Cerates, 4
Cera'tum, 407
Cerebral depressants, 641
  stimulants, 640, 691
Cerebritis
  veratrum, 292
Ce'reus grandiflo'rus, 295
Ce'rium oxalate, 591
Ceta'ceum, 408
Chalk, preparations of, 194
Chamomile, 568
  German, 568
Champagne, 722
Chancre and Chancroid
  mercuric nitrate, 30
  hydrogen dioxide, 83
  quinine, 126
  eucalyptus, 337
  iodoform, 337
  silver nitrate, 386
  copper sulphate, 397
  naphthalene, 624
  calomel, 624
  hydrastine, 799
Chapping
  camphor, 275
  lanolin, 407
  expressed oil of almond, 428
  glycerin, 432, 482
  witchhazel, 432
  benzoin, 482
Charcoal, 15, 93
Chemical constitution and physiological action, 9
Chenopo'dium, 110
Cherry laurel, 513
  wild, 512
Cheyne-Stokes breathing, drugs which produce, 506
Cheyne-Stokes Respiration
  amyl nitrite, 351
Chilblains
  sulphurous acid, 93
  balsam of Peru, 100
  tincture of digitalis, 236
  thymol, 236
  aconite, 284
  nitric acid, 307
  rosin cerate, 330
  tannic acid, 361
  alum, 402
  benzoin, 482
  copaiba, 486
  capsicum, 575
  iodine, 829
Chima'phila, 842
Chira'ta, 558
Chloasma and Freckles
  potassium nitrate, 153
  veratrine, 294
  witchhazel, 372
  ammonium chloride, 429
  sweet almond, 429
  mercuric chloride, 429
  bismuth, 429
  thymol iodide, 429
  glycerin, 432
  lactic acid, 432
  benzoin, 482
  lemon juice, 572
  myrrh, 585
  salicylic acid, 630
  alcohol, 722
  iodine, 829
Chloral, hydrated, 749
Chloral, Hydrated, Poisoning by, 754
Chloralamide, 755
Chloralformamide, 755
Chlorbutanol, 756
Chloretone, 756
Chlorinated lime, 49
  soda, solution of, 49
Chlorine, 15, 49
Chloroform, 765
  commissions, 768, 776
Chlorosis
  iron salts, 209, 210, 211
  arsenic, 210, 220
  copper sulphate, 398
  sumbul, 564
  glycerophosphates, 791
  thymus extract, 823
Cholagogues, 551
Cholelithiasis. *See* Biliary Calculus
Cholera
  calomel, 35
  camphor, 276
  opium, 276, 309, 362, 738
  sulphuric acid, 309
  nitroglycerin, 354
  tannic acid, 362
  bismuth, 590
  phenyl salicylate, 633
  strychnine, 671
  alcohol, 723
  hydrated chloral, 754
  anticholeraic serum, 812
Cholera Infantum
  gray powder, 35
  sodium chloride, 172
  caffeine, 266
  enteroclysis, 463
  alcohol, 722
  opium, 738
Cholera Morbus. *See* Diarrhœa
Cho'ndrus, 434
Chordee
  monobromated camphor, 277
  amyl nitrite, 350
  hot sitz baths, 463
  cantharides, 477
  belladonna, 703
Chorea
  quinine, 132
  arsenic, 220
  musk, 278
  eucalyptus, 338
  nitroglycerin, 352
  antipyrine, 499
  sumbul, 564
  zinc valerate, 582
  asafetida, 584
  conium, 649
  cocaine, 658
  hydrated chloral, 753

Chorea
  chloralformamide, 756
  paraldehyde, 762
  ether, 780
  cimicifuga, 801
  cod liver oil, 845
Choroiditis
  mercuric chloride, 32
  pilocarpine, 445
Chromium trioxide, 315
Chrysophan, 605
Chrysarobin, 110, 604
Churchill's tincture, 829
Chyluria
  thymol, 98
Cigarettes, 4
Ciliary muscle, drugs acting on, 645
Cimici'fuga, 800
Cincho'na, 115
  relative action of alkaloids of, 125
Cinchonidine sulphate, 116
Cinchonine sulphate, 116
Cinchonism, 124
  hydrobromic acid, 125,
  bromides, 125
  ergotin, 125
Cineol, 335
Cinnaldehy'dum, 563
Cinnamic aldehyde, 563
Cinnamon, 562
Citrine ointment, 19
Citric acid, 302
Clarendon water, 195
Clark's powder, 130
Classification of drugs, 13
Clemens' bromide solution, 221
Cloves, 559
Clutterbuck's elaterium, 616
Clysters, 4
Co'ca, 653
Cocaine, 654
Cocaine Poisoning, 659
Cocainization, spinal, 658
Cocamania, 659
Co'ccus, 847
Cochineal, 847
Cocilla'ña, 516
Codeine, 748
Cod liver oil, 843
Coffee, 258, 261
Cohosh, black, 800
Co'la, 267
Colchicine, 619
Co'lchicum, 618
Colchisal, 619
Colds. *See* Catarrh.
Colic. *See also* Biliary and Renal Calculus
  sodium chloride, 171
  oil of cajuput, 335
  oil of rosemary, 341
  hot baths, 462
  hydrocyanic acid, 509
  oil of cloves, 561
  myristica, 562
  sumbul, 564
  peppermint, 566
  anise, 567
  fennel, 568
  caraway, 568
  pennyroyal, 568
  chamomile, 569
  capsicum, 575
  ginger, 576
  cardamom, 577
  valerian, 582
  asafetida, 584
  belladonna, 701
  opium and morphine, 737, 738
  hops, 763
  ether, 780
Colitis. *See also* Diarrhœa
  boric acid, 77
  sodium chloride, 171
  cubeb, 488
Collapse
  ammonia, 182, 183, 243
  digitalis, 243
  caffeine, 243, 266
  alcohol, 243, 723, 724
  kola, 268
  camphor, 276
  musk, 278
  amyl nitrite, 347, 348
  nitroglycerin, 352
  enteroclysis, 463
  piperine, 573
  capsicum, 575
  coca, 658
  strychnine, 671
  belladonna, 702
  opium, 742
  ether, 781
Collodion, 409
Colloidal mercury, 20
  silver, 384, 390
Colocynth, 613
Colophony, 330
Columbian spring, Saratoga, 210
Columbo, 553
Condylomata
  mercuric nitrate, 30
  sodium ethylate, 176
  mercurial ointment, 18
  arsenic, 218, 222
  glacial acetic acid, 307
  hydrochloric acid, 307
  chromium trioxide, 316
  potassium dichromate, 318
  silver nitrate, 386
  zinc chloride, 393
  alum, 402
  salicylic acid, 630
Condylomata, Syphilitic
  mercuric nitrate, 30
  phenol, 58
  nitric acid, 307
  glacial acetic acid, 307
Condy's fluid, 81
Coni'um, 647
Conjunctivitis
  calomel, 32
  mercurol, 38
  formaldehyde, 48
  boric acid, 77
  hydrogen dioxide, 83
  lithium salts, 190
  tannic acid, 361
  silver salts, 386, 388
  zinc salts, 397, 402
  copper sulphate, 397, 402
  alum, 402
  ferrous sulphate, 402

  barberry, 558
  bismuth, 589
  ergot, 796
Constipation
  calomel, 33, 607, 610, 611
  sulphur, 88, 150
  potassium bitartrate, 150
  senna, 151, 593, 605
  Rochelle salt, 165
  Seidlitz powder, 165
  magnesium salts, 192, 193, 194
  ferrous sulphate, 208
  nux vomica, 208, 604, 671
  arsenic, 220
  enemata, 412, 419, 433, 548, 595, 606
  flaxseed, 413
  olive oil, 415
  soap suppositories, 418
  compound licorice powder, 424, 495
  jalap, 425, 611
  expressed oil of almond, 428
  glycerin, 433
  tamarind, 592
  fig, 593
  prune, 593
  manna, 593, 605
  castor oil, 595
  aloes, 598
  rhubarb, 602
  frangula, 606
  oxgall, 606
  euonymus, 607
  leptandra, 609
  podophyllin, 607
  scammony, 610
  gamboge, 612
  belladonna, 614, 701
  colocynth, 614
  croton oil, 618
  lobelia, 651
Contrexéville water, 195
Contusions
  sodium chloride, 171
  alcohol, 171, 721
  ammonium chloride, 187
  arnica, 341
  witchhazel, 372
  opium, 379, 721, 737
  lead water, 379, 721, 737
  lead carbonate, 379
  capsicum, 575
Convalla'ria, 256
Convulsions. *See also* Eclampsia
  amyl nitrite, 350
  hot baths, 462
  oxygen, 533
  asafetida, 584
  calabar bean, 679
  bromides, 688
  hydrated chloral, 688, 753
  chloroform, 773
  ether, 781
Copa'iba, 484
Copper sulphate, 396
Coriander, 567
Corns
  caustic potash, 143
  arsenic, 218
  glacial acetic acid, 307
  salicylic acid, 630
Corn-silk, 471
  starch, 436
Cornutine, 791
Corrosive sublimate, 18
Corson's paint, 617
Coryza. *See* Catarrh
Cotton, 409
  gun, 409
  root bark, 797
Couch grass, 477
Cough. *See also* Bronchitis
  cerium oxalate, 591
  codeine, 740, 748
  heroine, 740, 744
  lactucarium, 764
  chloroform, 772
Counter-irritants, 298
Cox's hive syrup, 450
Cramp bark, 802
Cranesbill, 373
Cream of tartar, 165
Credé's ointment, 387
Creosotal, 527
Creosote, 527
Cre'sol, 52, 62
Cre'ta præpara'ta, 194
Cretinism
  thyroid extract, 818
Crotin, 617
Croton oil, 616
Croup, Membranous. *See* Diphtheria
Croup, Spasmodic
  amyl nitrite, 351
  alum, 493
  hot compress, 463
Cubeb, 486
Cucumber, bitter, 613
Culver's root, 609
Cumulative action, 7
Cu'pri su'lphas, 396
Curare, 646
Cu'sso, 103
Cypripe'dium, 582
Cystinuria
  ammonium carbonate, 185
Cystitis
  iodoform, 69
  boric acid, 78
  oil of thyme, 99
  quinine, 125
  potassium acetate, 147
  potassium citrate, 147
  lime water, 197
  nitric acid, 308
  oil of turpentine, 325
  oil of cajuput, 335
  oil of eucalyptus, 339
  tannic acid, 361
  gallic acid, 365
  witchhazel, 372
  alum, 401
  flaxseed, 412
  slippery elm, 425
  acacia, 426
  buchu, 466
  uva ursi, 467
  sabal, 468
  juniper, 469
  pareira, 469
  pichi, 469
  zea, 471
  cantharides, 476
  triticum, 478
  urotropin, 478, 479

- **Cystitis**
  - benzoates, 483
  - cubeb, 487
  - oil of santal, 489
  - saccharin, 490
  - capsicum, 576
  - thymol, 586
  - belladonna, 703

DANDELION, 559

- Definitions, 1
- Deliritants, 640
- **Delirium Tremens.** *See* Alcoholism.
- Demulcents, 300
- Deodorants, 16
- Depressants, cerebral, 641
- **Dermatitis**
  - boric acid, 77
  - witchhazel, 372
  - kaolin, 406
  - lanolin, 407
  - lime water and lead, 408
  - olive oil, 413
  - expressed oil of almond, 428
  - bismuth, 572
  - glycerin, 572
  - lemon juice, 572
- Dermatol, 586
- Deshler's salve, 330
- **Diabetes Mellitus**
  - sodium carbonate, 162
  - sodium bicarbonate, 162
  - sodium phosphate 165
  - ammonium carbonate, 185
  - arsenic, 190, 221
  - opium, 365, 743
  - levulose (diabetin), 423
  - almond flour, 429
  - antipyrine, 499
  - valerian, 582
  - salicylates, 631
  - codeine, 744, 748
  - glycerophosphates, 791
- Diabetin, 422, 423
- Diachylon ointment, 374
  - plaster, 374
- Diaphoretics, 438, 440
- **Diarrhœa**
  - gray powder, 34
  - charcoal, 95
  - pomegranate, 105
  - sodium bicarbonate, 161, 162
  - chalk, 195, 368, 370
  - lime water, 197
  - arsenic, 219
  - caffeine, 266
  - camphor, 276
  - nitrous acid, 276, 309
  - opium, 276, 309, 368, 737
  - sulphuric acid, 309 370
  - nitric acid, 309
  - hydrochloric acid, 310
  - oil of turpentine, 322
  - oil of erigeron, 326
  - red gum, 340
  - arnica, 342
  - tannic acid, 363
  - gambir, 363, 367
  - kino, 363, 369
  - krameria, 363, 368
  - tannigen, 364
  - logwood, 370
  - geranium, 373
  - lead acetate, 380
  - silver nitrate, 389
  - bismuth, 395, 521, 590
  - pepsin, 395, 521
  - copper sulphate, 397
  - alum whey, 403
  - slippery elm, 425
  - benzoates, 484
  - ipecac, 521
  - zinc oxide, 521
  - calumba, 555
  - ginger, 576
  - castor oil, 596
  - rhubarb, 602
  - betanaphthol, 624
  - phenyl salicylate, 635
  - alcohol, 722
  - cannabis indica, 728
  - hydrated chloral, 754
  - hops, 763
  - chloroform, 772
  - nutrient serum, 814
  - iodine, 830
- **Diarrhœa, Chronic**
  - arsenic, 219
  - guarana, 267
  - tanalbin, 364
  - tannigen, 364
  - zinc salts, 395
  - copper sulphate, 397
  - cerium oxalate, 591
  - ergotin, 796
  - opium, 796
  - nux vomica, 796
- Diastase, 420
- Diethylsulphonmethylethylmethane, 758
- Digestants, animal, 577
- Digestive apparatus, drugs acting on, 533
- Digitalin, 231
- Digita'lis, 230
- Digitoxin, 231
- Dinner pill, 599
- **Diphtheria**
  - calomel, 36
  - mercuric chloride, 36
  - formaldehyde, 48
  - phenol, 59
  - potassium permanganate, 80
  - hydrogen dioxide, 83
  - sulphur, 87
  - sulphurous acid, 93
  - thymol, 97
  - balsam of Peru, 100
  - quinine, 125
  - potassium chlorate, 157
  - tincture of ferric chloride, 157, 208, 211
  - lime water, 193
  - hydrochloric acid, 308
  - lactic acid, 308
  - oil of turpentine, 322
  - oil of eucalyptus, 338
  - trypsin, 580
  - betanaphthol, 624
  - strychnine, 671
  - alcohol, 723
  - antidiphtheric serum, 805

- Diphtheria antitoxin, 804
- Direct action, 8
- Disinfectants, 14
- Dispermine, 471
- Dissolution, law of, 639
- Diuretics, 452, 458
- Diuretin, 470
- Dobell's solution, 59
- Dog button, 665
- Donovan's solution, 212, 222
- Doses, 5
  - for children, 5
- Dover's powder, 517
- Droitwich water, 171
- Drop chalk, 194
- **Dropsy**
  - potassium acetate, 147
  - potassium citrate, 147
  - potassium bitartrate, 150, 151, 611
  - jalap, 151, 610, 611
  - sodium acetate, 174
  - ammonium acetate, 188
  - magnesium sulphate, 193
  - arsenic, 221
  - digitalis, 244, 245, 256
  - calomel, 245, 256
  - squill, 245, 255, 256
  - convallaria, 257
  - caffeine, 264
  - erythrophlœum, 270
  - sugar of milk, 437
  - broom, 465
  - arbutin, 467
  - juniper, 467
  - diuretin, 470
  - zea, 471
  - taraxacum, 559
  - scammony, 610
  - elaterin, 615
- Durand's remedy, 323
- Dusart's syrup, 212
- **Dysentery**
  - charcoal, 95
  - pomegranate, 105
  - sodium sulphate, 165
  - ammonium chloride, 187
  - magnesium sulphate, 194, 309
  - arsenic, 219
  - sulphuric acid, 309
  - morphine, 309
  - nitrohydrochloric acid, 311
  - oil of turpentine, 322
  - opium, 322, 362, 380, 738
  - oil of erigeron, 326
  - boric acid, 362
  - tannic acid, 362
  - krameria, 369
  - geranium, 373
  - lead acetate, 380
  - silver nitrate, 389
  - zinc salts, 395
  - copper sulphate, 397, 398
  - alum, 401
  - flaxseed, 412, 433
  - slippery elm, 425
  - glycerin, 433
  - cold enemata, 462
  - hot irrigation, 463
  - benzoates, 484
  - ipecac, 520
  - cinnamon, 563
  - castor oil, 596
  - phenyl salicylate, 633
  - nux vomica, 671
- **Dysmenorrhœa**
  - boric acid, 78
  - sodium chloride, 171
  - aconite, 287
  - oil of cajuput, 335
  - amyl nitrite, 350
  - nitroglycerin, 353
  - sitz baths, 463
  - acetanilide, 498
  - salipyrine, 499
  - strychnine, 673
  - gelsemium, 682
  - bromides, 689
  - atropine, 700, 704
  - opium, 700
  - ergot, 796
  - apiol, 802
  - viburnum, 803
  - mammary extract, 824
- **Dyspepsia.** *See* Indigestion
- **Dysuria.** *See also* Cystitis
  - uva ursi, 467
  - triticum, 478

- EAR, drugs acting on, 646
- Easton's pill and syrup, 210
- Ecbolics, 784, 791
- **Eclampsia, Puerperal**
  - veratrum, 293
  - amyl nitrite, 349
  - morphine, 742
  - hydrated chloral, 753
  - chloroform, 773
- **Ecthyma**
  - calomel, 31
  - quinine, 133
- **Eczema**
  - calomel, 31, 624
  - mercuric nitrate, 31, 394
  - citrine ointment, 32
  - yellow mercuric oxide, 32
  - phenol, 58, 394, 432
  - sulphur, 87, 88
  - sulphurated lime, 90, 91
  - medicated baths, 90
  - thymol, 97
  - thymol iodide, 98
  - balsam of Peru, 100
  - chrysarobin, 111
  - prepared chalk, 195
  - lime water, 197
  - arsenic, 218, 222
  - aconite, 284
  - oil of turpentine, 322
  - tar, 328, 329, 394
  - oil of cade, 330, 394
  - oil of cajuput, 334
  - arnica, 342
  - witchhazel, 372, 432
  - lead salts, 379, 394
  - zinc salts, 379, 394
  - silver nitrate, 386
  - copper sulphate, 398
  - alum, 402
  - lanolin, 407
  - olive oil, 413
  - soft soap, 419

Eczema
- glycerin, 432
- bismuth, 432, 589
- oil of peppermint, 432
- creosote, 432
- pilocarpine, 444
- acetanilide, 497
- quillaja, 524
- oil of cloves, 561
- myrrh, 585
- naphthalene, 624
- salicylic acid, 630
- menthol, 653
- gelsemium, 682
- hydrated chloral, 752
- thyroid extract, 818
- ichthyol, 839

Effervescing powder, compound, 163

Ela'stica, 850

Elaterin, 615

Elephantiasis
- sulphurated lime, 91
- oil of cajuput, 335

Eli'xir, adjuvant, 424
- aromatic, 571
- fe'rri, quini'næ et strychni'næ phospha'tum, 115

Elm, 425

Emetics, 540

Emetine, 518

Emmenagogues, 784

Emollients, 300

Emphysema. *See also* Asthma and Bronchitis
- arsenic, 221
- squill, 256
- camphor, 276
- ipecac, 521
- terebene, 525
- grindelia, 531
- oxygen, 533
- calabar bean, 679
- cod liver oil, 844

Empirical therapeutics, 1

Endocarditis
- sodium phenolsulphonate, 65
- enteroclysis, 463
- antistreptococcic serum, 808

Endocervicitis and Metritis
- phenol, 58, 830
- chromium trioxide, 317
- tannic acid, 361
- silver nitrate, 386, 387
- ergotin, 796
- iodine, 829

Ene'mata, 4, 548

Enteritis. *See also* Diarrhœa
- silver salts, 387, 388, 399
- copper sulphate, 398
- flaxseed, 412
- tragacanth, 427
- cold baths, 461
- castor oil, 596

Enteroclysis, 3

Epididymitis
- colloidal mercury, 39
- ammonium chloride, 187
- silver nitrate, 386
- collodion, 410
- lobelia, 651

Epilepsy
- boric acid, 78
- quinine, 132
- amyl nitrite, 349
- blisters, 475
- antipyrine, 479
- acetanilide, 499
- acetphenetidin, 500
- zinc valerate, 582
- curare, 646
- bromides, 687
- belladonna, 704
- chloralformamide, 756
- paraldehyde, 762
- ergot, 796
- cod liver oil, 845

Epistaxis. *See also* Hæmorrhage
- aconite, 287
- krameria, 368
- witchhazel, 372
- antipyrine, 499
- ergot, 795, 796

Epithelioma. *See also* Cancer and Lupus.
- sodium ethylate, 176
- arsenic, 222,
- glacial acetic acid, 307
- lactic acid, 308
- pyrogallol, 367
- zinc chloride, 393

Epsom salt, 190

Ergot, 791

Ergotin, 791

Ergotism, 793

Erigeron, oil of, 326

Eriodi'ctyon, 531

Erysipelas
- mercuric chloride, 32
- citric acid, 32
- tartaric acid, 32
- resorcinol, 32
- ichthyol, 32
- mercurial ointment, 32
- phenol, 59, 61, 394
- iodol, 73
- boric acid, 76
- potassium permanganate, 81, 82
- sulphur, 87
- quinine, 133
- tincture of ferric chloride, 208, 211
- camphor, 274, 275
- aconite, 286
- arnica, 342
- witchhazel, 372
- lead salts, 379
- silver nitrate, 386
- zinc oxide, 394
- lanolin, 407
- collodion, 410
- flaxseed, 412
- slippery elm, 425
- pilocarpine, 444, 445
- acetanilide, 497
- betanaphthol, 624
- chloroform, 772
- gutta percha, 772
- antistreptococcic serum, 808
- pneumococcic serum, 800
- ichthyol, 839

Erythema
- phenol, 58
- quinine, 133

  - prepared chalk, 195
  - nitric acid, 313
  - nitrohydrochloric acid, 313
  - tannic acid, 362
  - witchhazel, 372
  - lanolin, 407
  - glycerin, 432
  - lime water, 432
  - bismuth, 589
  - lycopodium, 848
  - purified talc, 851
- Erythro'phlœum, 268
- Erythrol nitrate, 356
- Erythro'xylon, 653
- Escharotics, 298
- Eserine, 675
- Ether, 778
  - acetic, 782
  - chloric, 765
  - nitrous, spirit of, 355
- Ethyl acetate, 782
  - alcohol, 711
  - carbamate, 762
  - chloride, 664
  - oxide, 778
  - urethane, 762
- Eucaine, 659
- Eucalyptol, 335
- Eucal'yptus, 335
  - gum, 335, 337
- Eugenol, 559
- Euo'nymus, 607
- Eupato'rium, 451
- Exalgine, 498
- Excretion, rate of, 7
- Expectorants, 505
- Extracts, organic, 815
- Eye, drugs acting on, 643

- FABIA'NA, 469
- Family pill, 447
- **Favus.** See Tinea
- Fel bo'vis, 606
- **Felon**
  - lead acetate, 379
- Fennel, 567
- Fe'rrum, 200
- **Fever**
  - quinine, 127
  - ammonium acetate, 188
  - aromatic sulphuric acid, 309
  - citric acid, 312
  - effervescing mixtures, 312
  - mustard baths, 334
  - spirit of nitrous ether, 356
  - glycerin, 432
  - sugar of milk, 437
  - eupatorium, 451
  - cold baths, 460, 497
  - acetanilide, 497
  - antipyrine, 497
  - acetphenetidin, 500
  - Dover's powder, 522, 743
  - peppermint tea, 566
  - tamarind whey, 592
  - alcohol, 723
- Fi'cus, 593
- Fig, 593
- **Filariasis**
  - thymol, 97
- Fir wood oil, 326
  - balsam of, 325
- Flag, sweet, 557
- **Flatulence.** *See* Colic and Indigestion
- Flaxseed, 411
- Fleabane, oil of, 326
- Flexible collodion, 409
- Flitwick water, 210
- Flowers of sulphur, 84
- Fœni'culum, 567
- Formaldehyde, 15, 46
- Formalin, 46
- Fowler's solution, 212
- Foxglove, 230
- Fra'ngula, 606
- Franz Joseph water, 164
- Franzensbad water, 164
- **Freckles.** *See* Chloasma
- Friedrichshall water, 164, 547
- Friar's balsam, 479
- **Frost-bite**
  - ammonia, 181
  - lanolin, 407
  - benzoin, 482
  - copaiba, 486
  - storax, 527
  - alcohol, 722
- **Furuncle**
  - phenol, 60
  - iodoform, 70
  - sulphurated lime, 91
  - arsenic, 222
  - arnica, 341
  - silver salts, 386, 387
  - poultices, 406, 411, 425
  - collodion, 410
  - menthol, 653
  - belladonna, 699
  - hydrated chloral, 752
  - chloroform, 772
  - gutta percha, 772

- GALACTAGOGUES, 785
- Ga'lla, 357
- **Gall-stones.** *See* Biliary Calculus.
- Gambir, 367
- Gamboge, 612
- **Ganglion**
  - phenol, 59
- **Gangrene**
  - sodium sulphite (of lungs), 89
  - sodium thiosulphate (of lungs), 89
  - thymol (of lungs), 97
  - ammonium chloride, 187
  - camphor, 276
  - oil of eucalyptus (of lungs), 338, 339
  - zinc chloride, 393
  - salicylic acid, 630
  - alcohol, 723
- Gargari'smata, 4
- Gargles, 4
- **Gastralgia.** *See also* Indigestion
  - phenol, 60
  - sodium bicarbonate, 161
  - sinapisms, 332
  - nitroglycerin, 352
  - lead acetate, 380
  - zinc oxide, 395
  - blisters, 474
  - hydrocyanic acid, 509
  - oil of cloves, 561
  - lavender, 565
  - myrrh, 586

Gastralgia
bismuth, 590
atropine, 701
zinc sulphate, 701
alcohol, 722
carbon disulphide, 849
Gastric antiseptics, 538
juice secretion, drugs acting on, 537
nerves, drugs acting on, 539
sedatives, 540, 586
vessels, drugs acting on, 539
Gastritis
silver salts, 388, 389, 390
acacia, 426
tragacanth, 427
bismuth, 590, 737
opium, 737
Gastro-intestinal irritants, 539
Gaulthe'ria, 632
Gelatin, 435
Gelse'mium, 680
Generation, drugs acting on organs of, 783
Gentian, 556
Gera'nium, 373
Gilead, balm of, 325
Gin, 469
Ginger, 576
Glanders, Human
sulphur iodide, 91
Gla'ndulæ suprarena'les si'ccæ, 819
thyroide'æ si'ccæ, 816
Glauber's salt, 163
Glaucoma
pilocarpine, 445
calabar bean, 680
atropine, 700
Glonoin, spirit of, 351
Gluside, 489
Glycerin, 429
Glycerites, 429
Glycerophosphates, 790
Glyceryl trinitrate, 351
Glycogelatin, 435
Glycosuria, drugs causing, 552
diminishing, 553.
Glycyrrhi'za, 424
Glycyrrhizin, ammoniated, 424
Goitre
red mercuric iodide, 33
thyroid extract, 818, 831
thymus extract, 823
iodine, 830
Goitre, Exophthalmic
digitalis, 245
strophanthus, 250
cactus, 296
thymus extract, 823
ovarian extract, 825
splenic extract, 826
Gold and sodium chloride, 837
Golden seal, 797
Gonorrhœa and Gleet
mercurol, 38
phenol, 59
boroglycerin, 77
hydrogen dioxide, 83
oil of thyme, 99
balsam of Peru, 101
quinine, 125
lime water, 197
aconite, 285, 287
chromium trioxide, 316
oil of turpentine, 325
oil of eucalyptus, 337, 339
iodoform, 361
tannic acid, 361
gambir, 368
krameria, 369
kino, 370
geranium, 373
lead salts, 379, 397
zinc salts, 379, 394, 397
silver salts, 386, 387, 388
copper sulphate, 397
alum, 401
buchu, 466
uva ursi, 467
arbutin, 467
oil of juniper, 469
pareira, 469
cantharides, 474, 476
triticum, 478
benzoates, 483
copaiba, 486
cubeb, 487
oil of santal, 489
storax, 527
grindelia, 531
bismuth, 589
hydrated chloral, 752
methylene blue, 765
hydrastis, 798
Gossy'pii co'rtex, 797
Goudron, eau de, 329
Goulard's cerate and extract, 374
Gourd, bitter, 613
Gout
potassium bicarbonate, 145
potassium acetate, 147
potassium citrate, 147
Carlsbad waters, 166
lithium salts, 189, 689, 838
aconite, 284
veratrine, 294
piperazine, 471
colchicum, 621, 622
salicylates, 631
guaiac, 838
acetone, 850
Grana'tum, 104
Gravel
potassium acetate, 149
potassium citrate, 149
nitric acid, 313
zea, 471
urotropin, 479
benzoates, 483
glycerophosphates, 791
Graves' Disease. *See* Exophthalmic Goitre.
Gray powder, 18
Green mercurous iodide, 19
Paris, 224
Scheele's, 224
Schweinfurth's, 224
soap, 417
solution, 630

- Greene's ointment, 77
- Grinde'lia, 530
- Guaiac, 837
- Guaiacol, 529
- Guara'na, 267
- Guaranine, 257
- Gum arabic, 425
  - Benjamin, 479
  - eucalyptus, 335, 337
  - red, 335, 337
- Gun cotton, 409
- Guy's pill, 256
- Gypsum, dried, 851

- HAARLEM oil, 330
- Hæmatintics, 135
- **Hæmatochyluria**
  - potassium dichromate, 318
- Hæmato'xylon, 370
- **Hæmaturia**
  - sodium thiosulphate, 90
  - gallic acid, 365
  - gambir, 368
  - cantharides, 496
- **Hæmophilia**
  - calcium chloride, 200
  - gallic acid, 365
  - ergot, 796
  - thymus extract, 822
- **Hæmorrhage**
  - hydrogen dioxide, 83
  - potassium nitrate (of lungs), 153
  - calcium chloride, 200
  - iron salts, 207, 208
  - digitalis, 247
  - caffeine sodio-benzoate, 266
  - sulphuric acid, 308, 309
  - oil of turpentine, 324
  - oil of erigeron (of lungs), 326
  - arnica, 342
  - tannic acid, 360, 362
  - gallic acid, 365
  - gambir, 368
  - krameria, 368
  - witchhazel, 372
  - lead acetate, 380, 381
  - copper sulphate, 397
  - alum, 401, 402, 403
  - barium salts, 405
  - ice, 461
  - enteroclysis, 463
  - oil of santal (urethral), 489
  - matico, 489
  - ipecac, 522, 795
  - creosote, 528
  - strychnine, 672
  - ergot, 672, 794, 795
  - gelsemium (of lungs), 682
  - alcohol, 723
  - opium, 739, 743
  - hydrated chloral (of lungs), 752
  - chloroform, 772
  - hydrastinine, 799
  - suprarenal extract, 821
  - thymus extract (of lungs), 823
  - iodine, 830
- **Hæmorrhoids**
  - phenol, 60
  - sulphur, 88
  - chrysarobin, 112
  - iodoform, 112
  - sodium ethylate, 176
  - chromium trioxide, 317
  - belladonna, 329, 699
  - tar, 329
  - tannic acid, 329
  - nutgall and opium, 361, 737
  - logwood, 370
  - witchhazel, 372, 432
  - flaxseed, 412, 413
  - olive oil, 415
  - glycerin, 432
  - douching, 462
  - antipyrine, 499
  - myristica, 562
  - cascara sagrada, 603
  - potassium bromide, 687
  - stramonium, 707
  - ergot, 799
  - hydrastis, 799
- Hæmostatics, 299
- **Hair, Superfluous.** *See* Hirsuties
- Hamame'lis, 371
- Habit, 5
- Harrogate water, 91
- Hartshorn, 183
- Haschisch, 726
- **Hay Fever.** *See also* Asthma
  - phenol, 59, 831
  - quinine, 125, 133
  - arsenic, 221, 836
  - grindelia, 531
  - eriodictyon, 532
  - lobelia, 651
  - menthol, 653
  - cocaine, 657
  - suprarenal extract, 821
  - iodine, 831
  - potassium iodide, 836
- Hazeline, 372
- **Headache.** *See also* Migraine and Neuralgia
  - ammonia, 184
  - ammonium acetate, 188
  - magnesium salts, 192
  - caffeine, 266
  - guarana, 267
  - camphor, 275
  - menthol, 275
  - mustard, 333, 334
  - eucalyptus, 339
  - amyl nitrite, 350
  - spirit of nitrous ether, 350
  - blisters, 474
  - acetanilide, 498
  - antipyrine, 499
  - acetphenetidin, 500
  - ipecac, 519
  - lavender, 565
  - phenyl salicylate, 634
  - hydrobromic acid, 691
  - belladonna, 701
  - cologne water, 721
- Heart, drugs acting on, 227, 230
- **Heart, Organic Diseases and Functional Derangements of**
  - calomel, 35
  - digitalis, 35, 236, 243

- **Heart, Organic Dis. of**
  - squill, 35, 255
  - arsenic, 221
  - strophanthus, 251, 252
  - adonidin, 254
  - convallaria, 257
  - caffeine, 264, 671
  - kola, 268
  - erythrophlœum, 270
  - aconite, 286, 287
  - cactus, 296
  - amyl nitrite, 346
  - nitroglycerin, 353
  - erythrol nitrate, 357
  - barium salts, 405
  - sparteine, 465
  - oil of juniper, 469
  - diuretin, 470
  - zea, 471
  - hydrocyanic acid, 509
  - wild cherry, 513
  - grindelia, 531
  - oxygen, 533
  - valerian, 582
  - nux vomica and strychnine, 671
  - belladonna, 701
  - morphine, 739
  - chloroform, 772
  - suprarenal extract, 821
  - ether, 780
- **Heart-burn.** *See also* Indigestion
  - sodium bicarbonate, 161
  - ammonia, 184
  - magnesium salts, 192
  - atropine, 701
  - hydrochloric acid, 701
- **Heart Failure.** *See* Collapse
- Heat as an antiseptic, 74
  - bodily, drugs acting on, 490
- Heaton's method, 362
- Hedeo'ma, 568
- Hemlock, spotted, 647
- Hemp, Indian, 725
  - Canadian, 470
- Henbane, 707
- Hepatic depressants, 552
  - stimulants, 551
- **Hepatitis**
  - ammonium chloride, 186
  - aconite, 285
  - veratrum, 292
- **Hernia**
  - collodion (umbilical), 410
  - chloroform, 773
  - ether, 780, 781
- Heroine, 729
- **Herpes**
  - calomel, 31
  - camphor, 275
  - tannic acid, 362
  - witchhazel, 372
  - lead carbonate, 379
  - zinc carbonate, 379
- **Herpes Zoster**
  - calomel, 31
  - aconite, 284
  - veratrine, 294
  - diachylon ointment, 379
  - collodion, 410
  - grindelia, 531
  - menthol, 653
  - chloroform, 772
  - gutta percha, 772
- Hexamethylenamine, 478
- **Hiccough**
  - musk, 278
  - mustard, 334
  - oil of cajuput, 335
  - amyl nitrite, 348
  - nitroglycerin, 352
  - pilocarpine, 445
  - menthol, 653
  - belladonna, 702
  - morphine, 742
- Himrod's cure, 707
- **Hirsuties**
  - hydrogen dioxide, 83
  - sodium ethylate, 176
  - barium sulphide, 405
- Hive syrup, 255, 450
- Hoffmann's anodyne, 778
- Holocaine, 661
- Homatropine hydrobromide, 705
- Honey, 592
- Hope's camphor mixture, 276, 309
- Hops, 763
- Horehound, 451
- Hu'mulus, 763
- Hunyadi János, 164, 547
- Hydragogues, 546
- Hydra'rgyrum, 18
- Hydrastine, 797
- Hydrastinine, 797
- Hydra'stis, 797
- Hydrated chloral, 749
- Hydriodic acid, 831
- Hydrobromic acid, 691
- **Hydrocele**
  - phenol, 60
  - silver nitrate, 387
  - hydrated chloral, 752
- Hydrochloric acid, 302
  - ether, 664
- Hydrocyanic acid, 506
- **Hydrocyanic Acid Poisoning**, 510
- Hydrogen dioxide, 15, 82
- Hydrophobia antidote, 814
- Hydroquinone, 56
- Hydrous wool-fat, 406
- Hyoscine, 707
- Hyoscyamine, 707
- Hyoscy'amus, 707
- **Hyperidrosis**
  - formaldehyde, 49
  - picrotoxin, 114
  - chalk, 195, 630
  - arsenic, 222
  - camphor, 277
  - diachylon ointment, 379
  - copper sulphate, 398
  - salicylic acid, 630
  - belladonna, 699
  - atropine, 701
  - spirit lotions, 721
  - hydrated chloral, 752
  - hydrastis, 798
- Hypnotics, 641
- **Hypochondriasis and Melancholia**
  - arsenic, 220
  - caffeine, 266
  - valerian, 582
  - myrrh, 586
  - scammony, 610
  - colocynth, 614
  - opium, 741
  - paraldehyde, 762

  - gold and sodium chloride, 837
- Hypodermatic injections, 2
- Hypodermatoclysis, 3, 172
- Hypophosphites, 789
- Hypophosphorous acid, 789
- **Hysteria**
  - sodium phosphate, 166
  - camphor, 275, 277
  - oil of eucalyptus, 338
  - oil of rosemary, 341
  - blisters, 475
  - sumbul, 564
  - lavender, 565
  - ether, 565
  - valerian, 582, 584
  - asafetida, 584, 599
  - myrrh, 586, 599
  - aloes, 599
  - strychnine, 671
  - bromides, 688
  - atropine, 702
  - hyoscine, 709

- ICE BAGS, 461
- Ice-water baths, 461
- Ichthyol, 839
- **Ichthyosis**
  - potassium bicarbonate, 144
  - sodium carbonate, 160
  - lanolin, 407
- Idiosyncrasy, 5
- **Illuminating Gas, Poisoning by**
  - sodium chloride, 172
  - ammonia, 182
  - nitroglycerin, 354
  - oxygen, 533
- Imperial drink, 151
- **Impetigo**
  - calomel, 31
  - quinine, 133
  - nitric acid, 307, 313
  - nitrohydrochloric acid, 313
  - lanolin, 406
- **Impotence**
  - douching, 462
  - sabal, 468
  - cantharides, 576
  - strychnine, 672
  - phosphorus, 786
- Index, 853
- India rubber, 850
- Indian cannabis, 725
  - hemp, 725
  - tobacco, 650
- **Indigestion**
  - phenol (flatulent), 60
  - sodium phenolsulphonate (fermentative), 65
  - boric acid (fermentative), 78
  - potassium permanganate, 81
  - hydrogen dioxide, 83
  - sodium sulphite (fermentative), 89
  - sulphurous acid (fermentative), 93
  - charcoal, 95
  - thymol, 97
  - cinchona, 126, 671
  - potassium bicarbonate 144
  - sodium bicarbonate, 163, 566, 580, 602
  - gentian, 163, 310, 556, 571
  - bismuth, 163
  - ammonium carbonate, 184
  - magnesium salts, 192
  - calcium carbonate, 195
  - lime water, 197
  - calcium chloride (fermentative), 200
  - arsenic, 219
  - caffeine, 266
  - camphor (flatulent), 275
  - lavender (flatulent), 275
  - hydrochloric acid, 310, 579, 670
  - nux vomica, 310, 670
  - phosphoric acid, 310
  - nitrohydrochloric acid, 310
  - oil of turpentine (flatulent), 322
  - oil of cajuput (flatulent), 335
  - eucalyptus, 338
  - oil of rosemary (flatulent), 341
  - aromatic spirit of ammonia (flatulent), 356
  - spirit of nitrous ether (flatulent), 356
  - gallic acid (pyrosis), 365
  - kino (pyrosis), 370
  - lead acetate, 380
  - zinc salts, 395, 701
  - extract of malt, 422
  - cubeb, 488
  - wild cherry, 513
  - ipecac, 519, 520
  - terebene (fermentative), 525
  - calumba, 555
  - ginger (flatulent), 555, 576
  - quassia, 557
  - calamus (flatulent), 557
  - chirata (flatulent), 558
  - serpentaria, 558
  - taraxacum, 559
  - oil of cloves, 561
  - oil of cinnamon (fermentative), 561
  - peppermint, 561, 566
  - creosote (fermentative), 561
  - sumbul, 564
  - lavender (flatulent), 565
  - chamomile, 569
  - pepper (flatulent), 573
  - pepsin, 578
  - pancreatin, 579
  - myrrh, 586
  - rhubarb, 602
  - cascara sagrada, 603
  - euonymus, 607
  - leptandra, 609
  - resorcinol (fermentative), 625
  - menthol, 653

- **Indigestion**
  - coca, 658
  - calabar bean, 679
  - atropine, 701
  - alcohol, 722
  - morphine, 737
  - chloroform, 770
  - ether, 780
  - hydrastis, 799
  - gold and sodium chloride, 837
- Indirect action, 8
- **Influenza.** *See also* Coryza
  - formaldehyde, 48
  - phenol, 59, 61
  - quinine, 132
  - camphor, 276
  - chloroform, 276
  - lavender, 276
  - eucalyptus, 339
  - eupatorium, 451
  - acetanilide, 498
  - antipyrine, 490
  - acetphenetidin, 500
  - phenyl salicylate, 634
  - bromoform, 777
- Infusions, intravenous, 2
- Inhalations, 4
- Injections, 37, 38
  - hypodermatic, 2
  - intravenous, 2, 172
- **Insolation**
  - turpentine, 323
  - ice-water baths, 461
- **Insomnia**
  - hot baths, 463
  - sumbul, 564
  - bromides, 687
  - belladonna, 703
  - hyoscine, 709
  - cannabis indica, 728
  - opium, 741
  - hydrated chloral, 753
  - chloralformamide, 755, 756
  - chloretone, 757
  - sulphonal, 758
  - trional, 759
  - veronal, 760
  - paraldehyde, 761
  - ethyl carbamate, 762
  - hops, 763
  - lactucarium, 764
- Insufflations, 4
- **Intertrigo.** *See* Erythema
- Intestinal antiseptics, 548, 623
  - astringents, 549
- Intestines, drugs acting on, 544
- Intra-ocular tension, 645
- **Intussusception**
  - sodium bicarbonate, 162
  - tartaric acid, 162
- Inunction, 4
- Iodides, 832
- Iodine, 827
- Iodism, 833
- Iodoform, 66
- Iodol, 66, 72
- Iodo-tannin, 362
- Iodothyrin, 816
- Ions, theory of, 9
- Ipecacua'nha, 516
- **Iritis**
  - mercuric chloride, 32
  - mercurials internally, 36
  - pilocarpine, 445
  - blisters, 475
  - grindelia, 531
- Iron, 200
  - preparations of, 200, 211
  - Quevenne's, 200
- Irritants, 297
  - gastro-intestinal, 539
- Itch. *See* Scabies
- Itrol, 384, 387

- JABORANDI, 440
- Jaborine, 444
- Jalap, 611
- Jamestown weed, 706
- Jarisch's ointment, 367
- Jasmine, yellow, 680
- **Jaundice**
  - potassium bicarbonate, 146
  - sodium phosphate, 165
  - ammonium chloride, 186
  - nitrohydrochloric acid, 311
  - olive oil, 416
  - pilocarpine, 445
  - ipecac, 521
  - taraxacum, 559
  - aloes, 599
  - cascara sagrada, 603
  - podophyllin, 609
  - hydrastis, 799
- Jervine, 289
- Juniper, 468
  - tar oil, 329

- KAMA'LA, 103
- Kaolin, 405
- Kemp-Gardner, method, 776
- **Keratitis**
  - pilocarpine, 445
- Ki'no, 369
- Kissingen water, 164
- Kola, 267
- Kombé poison, 249
- Kou'sso, 103
- Krame'ria, 368

- LABARRAQUE'S solution, 49
- La Bourboule, 210, 223
- Lac su'lphuris, 84
- Lactic acid, 303
- Lactose, 437
- Lactuca'rium, 764
- Lady Webster's pill, 597
- Ladies' slipper, 582
- Lanolin, 406
- La'pis divi'nus, 397
- La'ppa, 841
- Lard, 407
- **Laryngismus Stridulus**
  - musk, 278
  - amyl nitrite, 351
  - nitroglycerin, 352
  - ipecac, 519
  - gelsemium, 682
  - belladonna, 702
  - hydrated chloral, 753
- **Laryngitis**
  - thymol, 97
  - balsam of Peru, 101
  - ammonium carbonate, 186
  - camphor, 275
  - menthol, 275
  - oil of turpentine, 322

  - oil of pine, 326
  - tar, 328
  - oil of cajuput, 335
  - tannic acid, 360, 361
  - tannigen, 364
  - silver nitrate, 387, 388
  - alum, 404
  - petrolatum, 409
  - acacia, 426
  - glycerin, 432
  - creosote, 432
  - oil of peppermint, 432
  - benzoin, 482, 484
  - bromides, 689
- **Laryngitis, Tuberculous**
  - lactic acid, 308
  - sabal, 468
  - menthol, 653, 741, 752
  - orthoform, 663, 741
  - morphine, 740
  - iodoform, 740
  - boric acid, 741
  - camphor, 752
  - hydrated chloral, 752
  - iodine, 831
  - turpentine, 831
- Laudanum, 729
- Lauroce'rasus, 513
- Lavender, 564
- Laxative tincture, 603
- Laxatives, 545, 592
- **Lead Poisoning**, 381
- Lead salts, 374
  - water, 374
- Lemon, 571
- **Lepra**
  - nitric acid, 307
- **Leprosy**
  - pyrogallol, 367
  - copaiba, 486
- Lepta'ndra, 609
- Lettuce, 764
- **Leucorrhœa**
  - phenol, 58
  - boroglycerin, 77
  - boric acid, 77
  - hydrogen dioxide, 83
  - oil of thyme, 99
  - balsam of Peru, 101
  - ammonia, 181
  - ammonium chloride, 187
  - lime water, 197
  - camphor, 275
  - chromium trioxide, 316
  - tannic acid, 361, 362
  - gambir, 368
  - krameria, 369
  - logwood, 370
  - geranium, 373
  - lead lotions, 379, 380
  - zinc sulphate, 379
  - alum, 401
  - douching, 462
  - bismuth, 589
  - hydrastis, 798
- **Leukæmia**
  - thymus extract, 823
- Levant wormseed, 106
- Levico water, 210, 223
- Levulose, 422, 423
- **Lichen**
  - phenol, 58
  - sodium carbonate, 160
  - arsenic, 222
  - sulphuric acid, 313
  - tar, 328
  - oil of cade, 330
  - silver nitrate, 386
  - talc, 851
- Licorice, 424
- Lily of the valley, 256
- Lime, 196
  - chlorinated, 49
  - milk of, 197
  - preparations of, 196
  - sulphurated, 15, 90
- Limo'nis co'rtex, 571
  - su'ccus, 572
- Linseed, 411
- Li'num, 411
- Li'quor antise'pticus, 479
  - chlo'ri compo'situs, 49
  - pi'cis carbo'nis, 328
  - so'dæ chlorina'tæ, 49
- Lister's ointment, 77
- Litharge, 374
- Lithium, 188
  - benzoate, 479
  - bromide, 683
  - carbonate, 188
  - citrate, 188
  - salicylate, 625
- Lithontriptics, 456
- **Liver, Cirrhosis of.** *See also* Dropsy
  - sodium phosphate, 165
  - arsenic, 222
  - nitrohydrochloric acid, 311
  - oil of juniper, 469
  - diuretin, 470
  - gold and sodium chloride, 837
- Liver, drugs acting on, 550
- Llangammarch wells, 405
- **Locomotor Ataxia**
  - sodium phosphate, 167
  - acetanilide, 498
  - antipyrine, 499
  - pyramidon, 499
  - chloralformamide, 755
  - methylene blue, 765
- Lob'elia, 650
- Local action, 8
  - anodynes, 636
  - anæsthetics, 636
- Logwood, 370
- London paste, 197
- Losophan, 66, 73
- Lo'tio fla'va, 20
  - ni'gra, 20
  - ru'bra, 393, 565
  - spi'ritus, 721
- Lugol's solution, 827
- **Lumbago.** *See* Myalgia
- Lunar caustic, 383
- Lupulin, 763
- **Lupus**
  - formaldehyde, 48
  - phenol, 58
  - lysol, 62
  - iodoform, 70
  - sulphur iodide, 91
  - thymol iodide, 98
  - chrysarobin, 111
  - caustic potash, 142
  - sodium ethylate, 176
  - arsenic, 218, 222
  - glacial acetic acid, 307

- **Lupus**
  - lactic acid, 308
  - chromium trioxide, 317
  - tar, 328
  - zinc chloride, 393
  - soft soap, 419
  - copaiba, 486
  - oil of cloves, 561
  - salicylic acid, 630
  - iodine, 829
- Lycetol, 471
- Lycopo'dium, 848
- **Lymphadenitis and Lymphangitis**
  - colloidal mercury, 39
  - sulphurated lime, 91
  - soft soap, 419
  - belladonna, 699
  - iodine, 829, 831
- Lysol, 62

- MAAS' PROCESS, 775
- Magnesia, 190
- Magnesium salts, 190
- **Malarial Fever**
  - phenol, 60
  - quinine, 127, 725
  - salicylates, 130
  - aloes, 131
  - rhubarb, 131
  - camphor, 131
  - arsenic, 220, 221
  - aconite, 286
  - nitric acid, 312
  - eucalyptus, 339
  - amyl nitrite, 351
  - tartar emetic, 450
  - ipecac, 450
  - pepper, 473
  - alcohol, 725
  - methylene blue, 765
  - hydrastis, 799
  - iodine, 831
- Male fern, 101
- Malt, 420
- Maltose, 421
- Mammary extract, 824
- Mandrake, 607
- Manganese dioxide, 801
  - hypophosphite, 789
  - sulphate, 801
- **Mania**
  - sodium nitrate, 174
  - aconite, 287
  - gelsemium, 287
  - veratrum, 292
  - scammony, 610
  - croton oil, 617
  - hyoscine, 709
  - morphine, 741
  - hydrated chloral, 753
  - chloralformamide, 756
  - potassium bromide, 756
  - paraldehyde, 762
  - methylene blue, 765
  - ergot, 796
- Ma'nna, 593
- Marienbad water, 164
- Marigold, 842
- Marru'bium, 451
- Marsden's paste, 218
- Marsh's test, 226
- Marshmallow, 435
- Mass, blue, 18
  - Vallet's, 201
- Mastic, 850
- **Mastitis**
  - belladonna, 702
- Ma'tico, 489
- Matrica'ria, 569
- May apple, 607
- Mazzoni's solution, 73
- McDade's formula, 839
- **Measles**
  - calomel, 36
  - opium, 36
  - sulphur, 87
  - aconite, 286
- Medullary anæsthe'sia, 658
- Mel, 592
- **Melancholia.** *See* Hypochondriasis
- **Ménière's Disease**
  - pomegranate, 105
  - hydrocyanic acid, 509
  - gelsemium, 682
- **Meningitis**
  - aconite, 285
  - opium, 742
- **Meningitis, Cerebro-spinal**
  - aconite, 285
  - turpentine, 323
  - colloidal silver, 390
  - morphine, 742
  - ergot, 796
- **Menorrhagia and Metrorrhagia**
  - boric acid, 78
  - digitalis, 317
  - chromium trioxide, 317
  - oil of erigeron, 326
  - uva ursi, 467
  - bromides, 689
  - ergot, 794
  - cotton root bark, 797
  - hydrastis, 799
  - viburnum, 803
  - mammary extract, 824
- Mental influences, 6
- Me'ntha piperi'ta, 565
  - vi'ridis, 566
- Menthol, 652
- Mercury, 18
  - modes of administration of, 39
  - preparations of, 18, 19, 20
  - in syphilis, 37
  - vegetable, 608
- **Mercury Poisoning**, 44–5
- Metabolism, drugs acting on, 827
- Methyl acetanilide, 498
  - morphine, 748
  - pyrocatechin, 529
  - salicylate, 632
- Methylene blue, 764
- Methylthionine hydrochloride, 764
- Mezere'um, 342
- Michel's paste, 304
- **Migraine**
  - picrotoxin, 114
  - ammonium acetate, 188
  - magnesium salts, 192
  - caffeine, 266
  - kola, 268
  - eucalyptus, 339
  - amyl nitrite, 350
  - nitroglycerin, 352
  - acetanilide, 498
  - exalgine, 498
  - pyramidon, 499
  - acetphenetidin, 500

  - ipecac, 519
  - sumbul, 564
  - salicylates, 631
  - gelsemium, 683
  - bromides, 689
  - cannabis indica, 728
  - ergot, 796
- Milk, drugs acting on, 911
  - drugs excreted by, 911
  - of asafetida, 583
  - of lime, 197
  - sugar of, 437
  - sulphur, 84
- Mindererus, spirit of, 187
- **Mollities Ossium**
  - calcium phosphate, 199
  - phosphorus, 786
- Monochlor-ethane, 664
- Monsel's solution, 207
- Morphine, 729
  - diacetic ester, 729
  - methyl, 748
- **Morphine Poisoning.** *See* Opium Poisoning.
- Morton's fluid, 830
- Mo'schus, 278
- Moss, Irish, 434
- Motor centres, drugs acting on, 639
  - nerves, drugs acting on, 635, 646
- Mountain balm, 531
- **Mucous Patches**
  - mercuric nitrate, 30
  - phenol, 58
  - chromium trioxide, 317
  - potassium dichromate, 318
- Muscles, drugs acting on, 634
- Muscular and nervous systems, drugs acting on, 634
- Musk, 278
- Musk root, 563
- Mustard, 331
- **Myalgia**
  - sodium chloride, 191
  - alcohol, 171
  - ammonium chloride, 186
  - camphor, 274, 752, 771
  - aconite, 284, 771
  - veratrine, 294
  - oil of turpentine, 321
  - sinapisms, 332
  - oil of cajuput, 332
  - oil of juniper, 341
  - oil of rosemary, 341
  - arnica, 341
  - pilocarpine, 446
  - eupatorium, 451
  - oil of peppermint, 566
  - belladonna, 699
  - alcohol, 722
  - Dover's powder, 743
  - hydrated chloral, 752
  - menthol, 752
  - methylene blue, —
  - chloroform, 771
  - petroleum benzin, 849
- Mydriatics, 645
- **Myelitis**
  - ergot, 796
- Myotics, 645
- Myri'stica, 562
- Myrrh, 585
- **Myxœdema**
  - thyroid extract, 818

NÆVUS
  - sodium ethylate, 176
  - zinc chloride, 393
- Nantwich water, 171
- Naphthalene, 624
- Narcotics, 641
- Narcotine, 749
- Nasal douches, 4
- Ne'bulæ, 4
- **Nephritis.** *See also* Dropsy
  - potassium acetate, 147
  - potassium citrate, 147
  - sodium chloride, 172
  - broom, 147, 465
  - ammonium acetate, 188
  - tincture of ferric chloride, 188
  - digitalis, 244, 256
  - calomel, 244, 256
  - squill, 244, 256
  - caffeine, 265
  - oil of erigeron, 326
  - oil of eucalyptus, 339
  - nitroglycerin, 352
  - erythrol nitrate, 357
  - pilocarpine, 444
  - enteroclysis, 463
  - juniper, 469
  - benzoates, 483
  - capsicum, 575
  - jalap, 611
  - potassium bitartrate, 611
  - morphine, 743
  - iodides, 835
  - gold and sodium chloride, 837
- Nerve trunks, drugs acting on, 637
- Nerves, drugs acting on, 635, 636, 637
- Nervous system, drugs acting on, 634
- **Neuralgia**
  - quinine, 132
  - sodium phosphate, 166
  - ammonia, 180
  - ammonium chloride, 186
  - caffeine, 266
  - kola, 268
  - camphor, 274, 752, 771
  - aconite, 284, 771
  - aconitine, 287, 699
  - veratrine, 294
  - oil of turpentine, 321
  - sinapisms, 332
  - oil of juniper, 341
  - oil of rosemary, 341
  - amyl nitrite, 350
  - nitroglycerin, 352
  - blisters, 474
  - acetanilide, 498
  - exalgine, 498
  - antipyrine, 499
  - pyramidon, 499
  - acetphenetidin, 500

Neuralgia
  oil of cloves, 561
  oil of peppermint, 565
  zinc valerate, 582
  menthol, 652, 653, 752
  chloroform, 652, 653, 771
  atropine, 653, 699, 704
  cocaine, 653
  morphine, 653, 741
  thymol, 653
  ethyl chloride, 664
  strychnine, 671
  gelsemium, 682
  bromides, 689
  belladonna, 699
  alcohol, 722
  cannabis indica, 728
  hydrated chloral, 752
  chloralformamide, 755
  methylene blue, 765
  ether, 780
  phosphorus, 786
  glycerophosphates, 791
  ovarian extract, 825
  cod liver oil, 844
  petroleum benzin, 849
Neurasthenia
  sodium phosphate, 166
  caffeine, 266
  cactus, 296
  eucalyptus, 338
  sumbul, 564
  nux vomica, 671
  phosphorus, 786
  glycerophosphates, 791
Neuritis
  blisters, 474
  methylene blue, 765
Nicotine, 636
Night blooming cereus, 295
Nightshade, deadly, 692
Night-sweats. *See also* Hyperidrosis
  formaldehyde, 49
  picrotoxin, 114
  quinine, 133
  camphoric acid, 277
  sulphuric acid, 308
  lead acetate, 381
  zinc oxide, 395
  belladonna, 395
  hyoscyamus, 395
  alum, 402
  salicylic acid, 630
  strychnine, 671
  atropine, 700
  veronal, 760
  ergot, 796
Nipples, Fissured
  balsam of Peru, 100
  krameria, 369
  lead nitrate, 379
  acacia, 426
  arrowroot, 426
  borax, 426
  glycerin, 432, 433
  witchhazel, 432
  benzoin, 433, 482
  copaiba, 486
  chloroform, 772
  gutta percha, 772
  hydrastis, 798
Nipples, to Harden
  tannin, 361
  glycerin, 361
  alum, 402, 721
  alcohol, 721
Nitre, 151
  sweet spirit of, 378
Nitric acid, 301
Nitrites, 343
Nitroglycerin, 351
Nitrohydrochloric acid, 302
Nitromuriatic acid, 302
Norwood's tincture, 289, 293
Nutgall, 357
Nutmeg, 562
Nutrient serum, 813
Nux vomica, 665
Nymphomania
  bromides, 689

OAK, WHITE, 357
Obesity
  Carlsbad waters, 166
  phytolacca, 623
Œdema, Pulmonary
  oxygen, 533
  suprarenal extract, 821
Œsophagus, Spasmodic Stricture of
  silver nitrate, 387
Œsypum, 406
Oil of allspice, 561
  almond expressed, 428
  American wormseed, 110
  anise, 566
  betula, 632
  bitter almond, 427
  cade, 329
  cajuput, 334
  caraway, 568
  Carron, 412
  cassia, 563
  castor, 594
  chenopodium, 110
  cinnamon, 563
  cloves, 559
  cod liver, 843
  copaiba, 484
  coriander, 567
  cotton seed, 409
  croton, 616
  cubeb, 487
  erigeron, 326
  eucalyptus, 335
  fennel, 567
  firwood, 326
  flaxseed, 411
  fleabane, 326
  gaultheria, 632
  Haarlem, 330
  hedeoma, 565
  juniper, 468
  lard, 407
  lavender flowers, 565
  lemon, 571
  linseed, 411
  mustard, volatile, 331
  myristica, 562
  olive, 413
  orange flowers, 571
    peel, 571
  pennyroyal, 568
  peppermint, 565
  pimenta, 561
  pine, 326
  rose, 570

  rosemary, 340
  santal, 488
  sassafras, 840
  savin, 799
  spearmint, 566
  sweet, 413
  sweet birch, 632
  tar, 327
  theobroma, 410
  thyme, 99
  turpentine, 318
  vitriol, 301
  wintergreen, 632
Oleic acid, 416
Oleum ri'cini, 594
  ti'glii, 616
Olive oil, 413
Ophthalmia Neonatorum
  mercurol, 38
  silver salts, 387, 388
Opium and its preparations, 728
  and morphine, differences in action, 736
  Patna, 738
Opium Poisoning, 745, 747
Opodeldoc, 416
Orange, 570
Orchitis
  mercurial ointments, 33
  oleate of mercury, 33
  silver nitrate, 386
Organic extracts, 815
Organisms infecting the body, drugs acting on, 13
Orthoform, 662
Osmosis, 12, 167
Osteomalacia. *See* Mollities Ossium
Otitis Media
  mercurol, 38
  iodoform, 70
  ammonium carbonate, 186
  lactic acid, 308
  pilocarpine, 445
  blisters, 474
  antistreptococcic serum, 808
Otorrhœa
  boric acid, 77
  hydrogen dioxide, 83
  tannic acid, 361
  lead lotions, 379
  zinc sulphate, 379
  hydrastis, 789
Ovarian extract, 824
Oxaluria
  nitrohydrochloric acid, 313
  zinc sulphate, 395
Oxgall, 606
Oxydicolchicine, 620
Oxygen, 532
Oxymel, 592
Oxytocics, 784
Ozæna
  iodoform, 69
  bismuth, 69, 589
  boroglycerin, 77
  potassium permanganate, 80
  hydrogen dioxide, 83
  sodium chloride, 171
  chromium trioxide, 316
  camphor, 329
  tar, 329
  iodine, 329, 829
  oil of eucalyptus, 338
  tannic acid, 361
  krameria, 369
  chlorinated soda, 369
  alum, 402
  saccharin, 490

PACK, COLD, 461
  hot, 462
Painter's palsy, 377
Pancreatin, 579
Papaverine, 749
Paraffin, 847
Paraldehyde, 760
Paralysis
  strychnine, 672
Paralysis Agitans
  arsenic, 220
  conium, 649
  cocaine, 658
  hyoscyamine, 709
  cod liver oil, 845
Paramorphine, 749
Parasiticides, 17
Paregoric, 729
Pare'ira, 469
Paresi's disguise for cod liver oil, 845
Paris green, 224
Parish's food, 212
Parsley, 802
Paste, London, 197
  Marsden's, 218
  Michel's, 304
  Ricord's, 303
  Vienna, 137
Pearson's solution, 212, 223
Pediculosis
  mercurials, 31
  sulphur, 87
  balsam of Peru, 100
  staphisagria, 113
  cocculus, 114
  oil of rosemary, 341
  soft soap, 419
  storax, 527
Pelletieri'næ ta'nnas, 104
Pellitory, 573
Pemphigus
  arsenic, 222
  tar, 328
Pennyroyal, 568
Pe'po, 105
Pepper, 572
  cayenne, 574
  Guinea, 574
Peppermint, 565
Pepsin, 577
Pericarditis
  calomel, 36
  aconite, 285
  veratrum, 293
Peritonitis
  mercurials externally, 33, 321
  calomel, 36, 738
  veratrum, 292, 293
  oil of turpentine, 321
  collodion (tuberculous), 410
  belladonna, 701
  opium, 701, 738
Pertussis
  formaldehyde, 48
  phenol, 59
  hydrogen dioxide, 84
  quinine, 125, 131
  ammonia, 182
  hydrocyanic acid, 509

Pertussis
  terpin hydrate, 526
  grindelia, 531
  bromides, 689
  belladonna, 702
  hydrated chloral, 753
  bromoform, 777
Peru, balsam of, 99
Peruvian bark, 115
Pessaries, 4
Petrola'tum, 408
Petroleum benzin, 848
Phagedæna
  nitric acid, 307
  pyrogallol, 367
Pharmaco-dynamics, 1
Pharmacognosy, 1
Pharmacological actions, 8
Pharmacology, definition of, 1
Pharyngitis
  boroglycerin, 77
  ammonium carbonate, 186
  camphor, 275
  aconite, 285
  oil of turpentine, 322
  tar, 328
  red gum, 340
  tannic acid, 360, 361
  witchhazel, 372
  geranium, 373
  rhus glabra, 373
  silver salts, 387, 388
  alum, 402, 404, 569
  petrolatum, 409
  flaxseed, 412
  licorice, 424
  acacia, 426
  tragacanth, 427
  glycerin, 432
  oil of peppermint, 432
  creosote, 432
  althæa, 435
  sabal, 468
  benzoin, 482
  sage, 569
  honey, 569
  infusion of rose, 570
  capsicum, 575
  myrrh, 585
  borax, 586
  belladonna, 702
  alcohol, 722
Phenacetin, 500
Phenazone, 498
Phenol, 15, 52
Phenol Poisoning, 64
Phenolsulphonate, sodium, 63
  zinc, 63
Phenylacetamide, 493
  dimethylpyrazolon, 498
  salicylate, 633
Phlebitis
  veratrum, 293
  colloidal silver, 387
Phosphaturia. *See* Gravel
Phosphoric acid, 302
Pho'sphorus, 785
Phosphorus Poisoning, 788
Physiological action, 8
Physosti'gma, 675
Physostigmine, 675
Phytola'cca, 622
Pichi, 469
Picrotoxin, 113
Pigme'nta, 4
Piles. *See* Hæmorrhoids
Pills, Blaud's, 200
  cathartic, compound, 19, 613
    vegetable, 608, 613
  chalybeate, 200
  Easton's, 210
  ferruginous, 200
  Guy's, 256
  Lady Webster's, 597
  laxative, compound, 597
  Trousseau's, 395
Piloca'rpus, 440
Pilocarpine, 441
Pi'lula tri'um phospha'tum, 210
Pime'nta, 561
Pink root, 109
Pinol, 326
Pi'per, 572
Piperazine, 471
Piperine, 572
Pipsi'ssewa, 842
Pituitary extract, 823
Pityriasis
  mercurials, 31, 482
  lysol, 62
  thymol, 97
  sodium carbonate, 160
  hydrochloric acid, 308
  oil of cade, 330
  pyrogallol, 367
  benzoin, 482
Pix li'quida, 327
Plague, Bubonic
  phenol, 61
  antiplague serum, 811
Plasma, drugs acting on, 133, 137
Plaster of Paris, 851
Plasters, 4
Platt's chlorides, 393
Pleurisy
  calomel, 36
  aconite, 285, 286
  veratrum, 292
  oil of turpentine, 321
  mustard poultices, 333
  olive oil, 416
  pilocarpine, 445, 446
  blisters, 474
  opium, 740
  chloroform, 772
  iodine, 829
  iodides, 835
Pleuro-pneumonia
  phenol, 60
Plumbism, 376
Pneumonia
  calomel, 36
  ammonium carbonate, 184, 559
  ammonium chloride, 186
  ammonium acetate, 188
  arsenic, 221
  digitalis, 245, 381
  caffeine, 266
  camphor, 276
  veratrum, 292
  oil of turpentine, 321, 324

mustard poultices, 333
lead acetate, 381
pilocarpine, 446
apomorphine, 516
creosotal, 529
oxygen, 533
serpentaria, 559
strychnine, 671
belladonna, 702
alcohol, 723
opium, 740
chloroform, 772
pneumococcic serum, 809
iodides, 835
Podophyllin, 608
Podophyllotoxin, 608
Podophy'llum, 607
Poison nut, 665
Poisons, 2
Poke root, 622
Pomegranate, 104
Pond's extract, 372
Posology, 5
Potash, caustic, 137
Pota'ssa, 137
Pota'ssium, 137
acetate, 146
alum, 400
and sodium tartrate, 163
arsenite, solution of, 212
bicarbonate, 144
bitartrate, 149
bromide, 683
carbonate, 144
chlorate, 154
citrate, 146
cyanide, 506
dichromate, 315, 317
ferrocyanide, 506
hydroxide, 137
hypophosphite, 789
iodide, 831
nitrate, 151
permanganate, 15, 79
prussiate, yellow, 506
salts, action of, 138
sulphate, 149
tartrate, acid, 149
Powder, Dover's, 577
gray, 18
Seidlitz, 163
Precipitate, red, 19
white, 18
Prickly Heat. *See* Lichen
Primary action, 8
Proof spirit, 711
Prostatitis
douching, 462
buchu, 466
oil of juniper, 469
cantharides, 476
capsicum, 576
belladonna, 703
ichthyol, 839
Protargol, 384, 387
Prune, 593
Pru'nus Virginia'na, 512
Prurigo
phenol, 58
sodium carbonate, 160
aconite, 284
sulphuric acid, 313
tar, 328
oil of cade, 330
hydrated chloral, 752
petroleum benzin, 849
Pruritus
black wash, 31
yellow wash, 31
boric acid, 77
sodium thiosulphate, 90
sulphurous acid, 93
balsam of Peru, 100
sodium carbonate, 160
lime water, 197
aconite, 284
sulphuric acid, 313
tar, 328
oil of cade, 330
tannic acid, 362
silver nitrate, 387
zinc oxide, 394, 772
glycerin, 394, 432
alum, 402
collodion, 410
oil of peppermint, 432
creosote, 432
douching, 462
hydrocyanic acid, 509
menthol, 653
cocaine, 657
gelsemium, 682
belladonna, 699
hydrated chloral, 752
chloroform, 772
talc, 851
Prussic acid, 506
Psoriasis
mercuric nitrate, 31
formaldehyde, 48
phenol, 58
sulphur, 87, 88
sulphurated lime, 90
thymol iodide, 98
chrysarobin, 111
sodium carbonate, 160
strophanthus, 253
oil of turpentine, 322
tar, 328, 329
oil of cade, 330
oil of cajuput, 334
pyrogallol, 367
copper sulphate, 398
lanolin, 407
olive oil, 413
soft soap, 419
copaiba, 486
betanaphthol, 623
calomel, 624
naphthalene, 624
chloroform, 772
gutta percha, 772
iodides, 836
ichthyol, 839
burdock, 841
Ptyalism. *See also* Mercury Poisoning
belladonna, 700
Puerperal Sepsis
formaldehyde, 48
phenol, 60
sodium phenolsulphonate, 65
potassium permanganate, 82
oil of turpentine, 321, 324
colloidal silver, 390
croton oil, 618
antistreptococcic serum, 880

- Pullna water, 164, 547
- Pu'lvis aroma'ticus, 562
  - efferve'scens compo'situs, 163
- Pumpkin seed, 105
- Pupil, drugs acting on, 643
- Purgatives, 545
  - anthracene, 604
  - drastic, 546, 607
  - hydragogue, 546
  - saline, 547
  - simple, 546, 597
- **Purpura Hæmorrhagica**
  - sulphurous acid, 93
  - ergot, 93, 796
  - potassium nitrate, 153
  - oil of turpentine, 324
  - alum, 402
- Pustulants, 298
- **Pustule, Malignant**
  - phenol, 57
- **Pyæmia.** *See also* Septicæmia
  - alcohol, 723
- **Pyelitis**
  - oil of turpentine, 325
  - oil of copaiba, 325
  - oil of cubeb, 325
  - oil of eucalyptus, 339
  - gallic acid, 365
  - buchu, 466
  - uva ursi, 467
  - oil of juniper, 469
  - pareira, 469
  - cantharides, 476
  - urotropin, 479
  - benzoates, 483
  - capsicum, 576
- Pyramidon, 498
- Pyre'thrum, 573
- Pyrocatechin, 56
- Pyrogallol, 364
- **Pyrosis.** *See* Indigestion
- Pyroxylin, 409

- QUAIN'S pill, 602
- Qua'ssia, 556
- Queen's root, 841
- Que'rcus, 357
- Quevenne's iron, 200
- Quicksilver, 18
- Quilla'ja, 504
- Quinine, 115
  - preparations of, 115, 116
  - specific action of, 127

- **RACHITIS**
  - calcium phosphate, 199
  - calcium lactophosphate, 199
  - ferrous iodide, 211
  - cod liver oil, 211
  - phosphorus, 786
  - thymus extract, 822
- **Rectum, Prolapse of**
  - silver nitrate, 387
  - alum, 401
  - logwood, 401
  - douching, 462
- Red corpuscles, drugs acting on, 135, 200
  - cinchona, 115
  - gum, 335
  - lotion, 393, 565
  - precipitate, 19
  - saunders, 847
  - wine, 711
- Refrigerants, 536
- Reinsch's test, 226
- Remote action, 8
- Resi'na, 330
- Resorcinol, 624
- Respiration, drugs acting on, 500
- Respiratory centre, drugs acting on, 502, 506
  - depressants, 502, 503
  - stimulants, 502
- **Retinitis**
  - mercuric chloride, 32
  - pilocarpine, 445
- Rha'mnus purshia'na, 602
- Rhatany, 368
- Rhe'um, 600
- **Rheumatism**
  - phenol, 60
  - sulphurated lime, 90
  - potassium bicarbonate, 145
  - potassium citrate, 146
  - potassium acetate, 147
  - sodium acetate, 174
  - ammonium chloride, 186
  - lithium salts, 189, 689
  - arsenic, 221
  - iodides, 221, 622, 835
  - camphor, 274
  - aconite, 284, 286
  - veratrum, 293
  - veratrine, 294
  - ferric chloride, 313
  - potassium dichromate, 318
  - oil of turpentine, 321
  - oil of cajuput, 334, 335
  - oil of juniper, 341
  - oil of rosemary, 341
  - arnica, 342
  - colloidal silver, 390
  - pilocarpine, 446
  - cold baths, 461
  - piperazine, 471
  - blisters, 474
  - benzoates, 484
  - antipyrine, 407
  - pyramidon, 499.
  - salipyrine, 499
  - Dover's powder, 522
  - lemon juice, 572
  - colchicum, 622
  - salicylates, 631
  - oil of wintergreen, 632
  - oil of betula, 632
  - methyl salicylate, 632
  - phenol salicylate, 633
  - salophen, 634
  - cocaine, 653
  - hydrated chloral, 653
  - menthol, 653
  - thymol, 653
  - morphine, 653
  - atropine, 653
  - chloroform, 653, 771
  - belladonna, 699
  - alcohol, 722
  - methylene blue, 765
  - xanthoxylum, 839
  - ichthyol, 840
  - chimaphila, 842

  cod liver oil, 844
  acetone, 850
Rheumatism, Muscular. *See* Myalgia
Rhinitis. *See also* Catarrh
  formaldehyde (atrophic), 48
  tannigen (chronic), 364
Rhubarb, 600
Rhus gla'bra, 372
Rhus Poisoning
  sodium thiosulphate, 90
  sodium bicarbonate, 161
  ammonium chloride, 187
  ipecac, 519
  grindelia, 530
Richfield Springs, 88, 383
Ricin, 594
Ricord's paste, 303
Ringworm. *See also* Tinea
  mercurials, 31
  sulphur iodide, 90
  thymol, 97
  balsam of Peru, 100
  chrysarobin, 112
  sodium ethylate, 176
  glacial acetic acid, 307
  oil of turpentine, 322
  pyrogallol, 367
  croton oil, 617
  betanaphthol, 623
  salicylic acid, 630
  iodine, 829
Ri'sus sardo'nicus, 673
Rochelle salt, 163
Rosacea
  sulphur, 87
  sulphur iodide, 91
  oil of cajuput, 334
  witchhazel, 372
Rose, 569
Rosemary, oil of, 340
Rosin, 330
Rottlera, 103
Rubber, 850
Rubefacients, 297
Rubinat, 547
  Condal, 164
Ru'bus, 374
Rush's thunderbolt, 611
Rye, ergot of, 791

SA'BAL, 468
  Sabi'na, 799
Saccharin, 489
Sa'ccharum, 422
  la'ctis, 437
Safrol, 840
Sage, 569
Sal alembroth, 19, 38
  ammoniac, 185
  diure'ticus, 147
  volatile, 183
Salicylates, 625
Salicin, 625
Salicylism, 629
Saligenin, 626
Saline solution, normal, 167
  physiological, 167
  purgatives, 547
Salipyrine, 498
Salivary glands, drugs acting on, 534
Salol, 633
Salophen, 634
Salt action, 167
  common, 167
  Epsom, 190
  Glauber's, 163
  Rochelle, 163
  of tartar, 144
Saltpetre, 151
Sa'lvia, 569
Sanguina'ria, 527
Santal, oil of, 488
Sa'ntalum ru'brum, 847
Santonin, 106
Sa'po, 416
  mo'llis, 418
Sarsapari'lla, 840
Sa'ssafras, 840
Sassy bark, 268
Satyriasis
  bromides, 689
Saunders, red, 847
Savin, 799
Saw-palmetto, 468
Scabies
  mercurials, 31
  chlorinated oil, 51
  sulphur, 87, 90, 92
  balsam of Peru, 100
  staphisagria, 113
  cocculus, 114
  tar, 328
  oil of cajuput, 335
  oil of rosemary, 341
  copper sulphate, 398
  storax, 527
  betanaphthol, 623
  petroleum benzin, 849
Scalds. *See* Burns.
Scammony, 610
Scarlatina
  formaldehyde, 48
  chlorine, 51
  phenol, 61
  potassium permanganate, 80
  sulphur, 87
  sulphurous acid, 93
  digitalis, 245
  aconite, 286
  lanolin, 407
  oil inunctions, 414
  capsicum, 575
  betanaphthol, 624
  antistreptococcic serum, 809
Scheele's green, 224
Schleich's infiltration method, 657
Schweinfurth's green, 224
Sciatica. *See also* Neuralgia
  camphor, 274
  aconitine, 285
  veratrine, 285
  hydrochloric acid, 307
  blisters, 474
  acetanilide, 498
  exalgine, 498
  salipyrine, 499
  acetphenetidin, 500
  ammonium carbonate, 703
  atropine, 704
  methylene blue, 765
  glycerophosphates, 791
Sci'lla, 254

- **Scleroderma**
  - lanolin, 406
- Scopa'rius, 464
- Scopo'la, 709
- Scopolamine, 709
- Scott's ointment, 33
- **Scurvy**
  - calcium chloride, 200
  - lemon, lime and orange juice, 314, 572
  - oil of turpentine, 324
  - pyrethrum, 574
  - alcohol, 722
  - thymus extract, 822
- Scutella'ria, 842
- **Seasickness.** *See also* Vomiting
  - amyl nitrite, 351
  - nitroglycerin, 352
  - calumba, 555
  - cerium oxalate, 591
  - cocaine, 658
  - bromides, 689, 756
  - hydrated chloral, 753
  - chloralformamide, 756
- **Seborrhœa**
  - calomel, 31
  - witchhazel, 372
  - lead salts, 379
  - zinc carbonate, 379
  - olive oil, 413
  - soft soap, 419
  - glycerin, 432
  - phenol, 432
  - bismuth, 432
  - sodium bicarbonate, 432
  - resorcinol, 625
  - hydrastis, 798
- Secondary action, 8
- Sedatives, gastric, 540, 586
- Seidlitz powder, 163
  - water, 164
- Se'nega, 522
- Senegin, 523
- Se'nna, 604
- Sensory nerves, drugs acting on, 636, 652
- **Septicæmia (Toxæmia)**
  - sodium phenolsulphate, 65
  - potassium permanganate, 82
  - colloidal silver, 390
  - enteroclysis, 463
  - alcohol, 723
- Serous cavities, injections into, 4
- Serpenta'ria, 558
- Serum, anticholera, 811
  - antidiphtheric, 804
  - antiplague, 810
  - antipneumococcic, 809
  - antistreptococcic, 808
  - antitetanic, 806
  - antityphoid, 812
  - antivenomous, 810
  - nutrient, 813
- Serums, 803
- Se'vum præpara'tum, 848
- **Shock.** *See* Collapse
- Sialogogues, 534
- Silver salts, 383
- Si'napis a'lba, 331
  - ni'gra, 331
- Skin, drugs acting on, 438
- Skullcap, 842
- **Small-pox**
  - phenol, 58
  - sulphur, 87
  - tannic acid, 362
  - benzoin, 362
  - silver nitrate, 386
  - collodion, 410
  - alcohol, 723
  - chloroform, 772
  - gutta percha, 772
- Snakeroot, black, 800
  - Virginia, 558
- Soap, 416
  - bark, 524
- Soda, 158, 161
  - baking, 161
  - caustic, 158
- Sodium, 158
  - acetate, 173
  - arsenate, 234
  - benzoate, 479
  - bicarbonate, 161
  - bisulphite, 88
  - borate, 74
  - bromide, 683
  - cacodylate, 213, 223
  - carbonate, 160
    - dried, 160
    - monohydrated, 160
  - chlorate, 174
  - chloride, 167
  - citrate, 175
  - ethylate, 175
  - glycerophosphate, 790
  - hydroxide, 158
  - hypophosphite, 789
  - iodide, 832
  - nitrate, 173
  - nitrite, 354
  - phenolsulphonate, 65
  - phosphate, 163
  - pyroborate, 74
  - pyrophosphate, 175
  - salicylate, 625
  - sulphate, 163
  - sulphite, 88
  - sulphocarbolate, 65
  - thiosulphate, 88
- Soporifics, 641
- Spanish beetles, 472
- Sparteine sulphate, 464
- Spearmint, 566
- Spermace'ti, 408
- **Spermatorrhœa**
  - digitalis, 246
  - bromides, 247, 689
  - oil of turpentine, 325
  - cold douching, 462
  - cantharides, 476
  - capsicum, 576
  - belladonna, 703
  - hyoscine, 709
  - lupulin, 763
  - ergot, 796
- Spige'lia, 109
- **Spina Bifida**
  - collodion, 410
  - iodine, 830
  - potassium iodide, 830
- Spinal cocainization, 658
  - cord, drugs acting on, 638, 665
- Spindle tree, 607
- Sphacelic acid, 792
- Spirit of Mindererus, 187
  - proof, 711

of wine, 711
Spi'ritus æ'theris nitro'si, 355
frume'nti, 711
vi'ni ga'llici, 711
Spleen, Enlarged
red mercuric oxide, 33
iodine, 835
red mercuric oxide, 836
iodides, 836
Splenic extract, 825
Sponging, cold, 461
Sprains
sodium chloride, 171
alcohol, 171, 721
oil of rosemary, 341
arnica, 341
witchhazel, 372
lead and opium, 379, 737
soap liniment, 418, 419
Sprays, 4
Squill, 254
Squire's chemical food, 212
Staphisa'gria, 112
Starch, 436
Stavesacre, 112
Stearates, 406
Stilli'ngia, 841
Stimulants, cerebral, 640, 641
hepatic, 551
Stomach, drugs acting on, 609, 536
Stomachics, 537, 553
Stomatitis. *See* Aphthæ
Storax, 526
Stramo'nium, 706
Strangury, 321, 473
potassium hydroxide, 143
flaxseed, 412
uva ursi, 467
opium, 475
Stro'ntium bromide, 683
iodide, 832
salicylate, 625
Strophanthin, 248
Stropha'nthus, 248
Strychnine, 665
Strychnine Poisoning, 674
Styptic collodion, 409
Styptics, 299
Sty'rax, 526
Sublimate, corrosive, 18
Sucrose, 422
Sudorifics, 439
Suet, prepared, 848
Sugar, 422
drugs causing it in urine, 552
Sulphocarbolates, 65
Sulphonal, 757
Sulphonethylmethane, 758
Sulphonmethane, 757
Su'lphur, 84
iodide, 90
vegetable, 848
Sulphuric acid, 301
Sumach, 372
Sumbul, 563
Sunburn. *See* Dermatitis and Freckles
Sunstroke. *See* Insolation
Suppositories, 4
of glycerin, 429
Suprarenal extract, 404, 819
Sweet almond, 428
birch, 632
flag, 557
oil, 413
orange peel, 570
spirit of nitre, 355
Sycosis. *See* Tinea
Sympathetic system, drugs acting on, 646
Syncope. *See also* Collapse
ammonia, 181, 183, 184
sinapisms, 332
amyl nitrite, 347
valerian, 582
alcohol, 723, 724
Synovitis. *See* Arthritis
Syphilis
mercurial treatment, 37
zal alembroth, 39
colloidal mercury, 39
mercurials hypodermatically, 42
mercurial fumigations, 43
mercurial baths, 44
mercurial inhalations, 44
iodoform, 70
potassium sulphide, 87
thymol iodide, 98
nitrohydrochloric acid, 313
potassium dichromate, 318
pyrogallol, 367
copper sulphate, 398
pilocarpine, 445
strychnine, 671
iodine, 831
potassium iodide, 834, 835
mixed treatment, 835
gold and sodium chloride, 837
xanthoxylum, 839
stillingia, 839, 840
Sy'rupus, 422
Systemic action, 8

TAKA-DIASTASE, 420
Talc, 850
Tamar indien, 605
Tamarind, 592
Tannalbin, 358, 363
Tannigen, 358, 364
Tannin, 358
Tar, 327
Tarasp water, 164
Ta'raxacum, 559
Tartar emetic, 446
cream of, 149
Tartaric acid, 303
Tea, 258
Teeth, drugs acting on, 533
Temperature, drugs causing rise of, 492
drugs decreasing, 490, 493
Terebene, 525
Terebi'nthina, 318
canade'nsis, 325

- Terpin hydrate, 526
- Testicular extract, 825
- **Tetanus**
  - phenol, 60, 61
  - amyl nitrite, 348
  - nitroglycerin, 353
  - curare, 646
  - calabar bean, 679
  - potassium bromide, 689
  - hydrated chloral, 689, 753
  - chloroform, 773
  - ether, 781
  - antitetanic serum, 806
- Tetanus antitoxin, 806
- Thebaine, 749
- Theine, 257
- Theobro'ma, oil of, 410
- Theobromine sodio-salicylate, 470
- Therapeutic actions, 8
- Therapeutics, 1
- Therapo-dynamics, 1
- Thermogenesis, 490
- Thermolysis, 490
- Thermotaxis, 491
- Thiersch's solution, 77
- Thompson's fluid, 77
  - solution, 786
- Thorn-apple, 706
- Thoroughwort, 451
- **Thrush.** *See* Aphthæ
- **Tic Douloureux.** *See also* Neuralgia
  - atropine, 704
  - glycerophosphates, 791
- Thyme, oil of, 99
- Thy'mol, 95
  - iodide, 98
- Thymus extract, 821
- Thyroid extract, 816
- Thyroiodin, 816
- Thyroidism, 819
- Tinctu'ra antiperio'dica, 131
  - laxati'va, 603
- **Tinea**
  - mercurials, 31, 32
  - phenol, 58
  - boric acid, 77
  - sulphur, 87
  - cocculus, 114
  - glacial acetic acid, 307
  - hydrochloric acid, 308
  - chromium trioxide, 317
  - tar, 328
  - oil of cade, 330
  - oil of cajuput, 335
  - diachylon ointment, 379
  - silver nitrate, 386
  - copper sulphate, 398
  - soft soap, 419
  - iodine, 829
- **Tinnitus Aurium**
  - amyl nitrite, 350
  - hydrobromic acid, 691
  - belladonna, 701
  - ergot, 796
- Tobacco, Indian, 650
- **Toe-nail, Ingrown**
  - tannic acid, 362
  - alum, 402
- Tolu, balsam of, 526
- Tonic, definition of, 827
- **Tonsillitis**
  - phenol, 59
  - hydrogen dioxide, 83
  - potassium chlorate, 156
  - sodium bicarbonate, 161
  - camphor, 275
  - aconite, 285
  - veratrum, 293
  - chromium trioxide, 317
  - oil of turpentine, 322
  - tannic acid, 361
  - alum, 402
  - glycerin, 432, 575
  - capsicum, 575
  - guaiac, 838
- **Toothache**
  - phenol, 59, 274, 653
  - sodium chloride, 171
  - camphor, 274, 652, 752
  - thymol, 274
  - oil of cajuput, 335
  - tannic acid, 362
  - creosote, 528
  - oil of cloves, 562
  - pyrethrum, 573, 574
  - capsicum, 575
  - menthol, 652, 752
  - hydrated chloral, 653, 752
  - xanthoxylum, 839
- Toxicology, definition of, 2
- Tragacanth, 427
- Tribromomethane, 777
- Trichloromethane, 765
- Trichlortertiary butylalcohol, 756
- Trional, 758
- **Trismus Nascentium**
  - amyl nitrite, 348
  - calabar bean, 679
- Tri'ticum, 477
- Troches, 4
- Trousseau's pill, 395
- Trypsin, 579
- **Tuberculosis, Pulmonary**
  - formaldehyde, 48
  - thymol, 97
  - balsam of Peru, 101
  - cinnamic acid, 101
  - calcium lac'tophosphate, 199
  - calcium chloride, 209
  - arsenic, 221
  - hydrochloric acid, 310
  - tar-water, 329
  - oil of eucalyptus, 338
  - extract of malt, 422
  - cod liver oil, 422, 528, 844
  - pyramidon, 499
  - hydrocyanic acid, 510
  - wild cherry, 513, 528
  - apomorphine, 516
  - terebene, 525
  - creosote, 528
  - hypophosphites, 528, 790
  - glycerin, 528
  - cresotal, 529
  - guaiacol, 530
  - oxygen, 533
  - alcohol, 724
  - iodine, 831

- turpentine, 831
- Turpentine, 318
  - Canada, 325
- Turpeth mineral, 19
- **Tympanites.** *See also* Indigestion
  - oil of turpentine, 322
- **Typhoid and Typhus Fevers**
  - calomel, 35
  - chlorine water, 52
  - phenol, 60
  - chloroform, 60
  - iodine, 61, 831
  - sodium phenolsulphonate, 65
  - zinc phenolsulphonate, 66
  - camphor, 276
  - hydrochloric acid, 310
  - sulphuric acid, 310
  - oil of turpentine, 323
  - bismuth, 380, 590
  - cold baths and applications, 460, 461
  - enteroclysis, 463
  - urotropin, 479
  - pyramidon, 499
  - guaiacol, 530
  - oxgall, 607
  - betanaphthol, 624
  - phenyl salicylate, 633
  - belladonna, 703
  - alcohol, 723
  - opium, 737
  - antityphoid serum, 813
  - nutrient serum, 814

- **ULCER**
  - mercurials, 30, 394
  - mercuric nitrate (venereal), 30
  - calomel (venereal), 31, 624
  - black wash, 31
  - formaldehyde (corneal and tuberculous), 48
  - phenol, 58
  - zinc phenolsulphonate, 65
  - iodoform, 69
  - boric acid, 76
  - potassium permanganate, 80
  - hydrogen peroxide, 83
  - sulphurous acid, 93
  - balsam of Peru, 100
  - potassium chlorate, 157
  - ammonium chloride, 187
  - prepared chalk, 195
  - lime water (gangrenous), 197
  - camphor, 275
  - glacial acetic acid, 307
  - nitric acid (venereal), 307
  - chromium trioxide, 316, 317
  - tannic acid, 317, 361
  - potassium dichromate (venereal), 318
  - oil of turpentine, 322
  - rosin cerate, 330
  - eucalyptus, 337
  - pyrogallol, 367
  - kino, 370
  - geranium, 373
  - rhus glabra, 373
  - lead salts, 380, 394
  - silver nitrate, 387
  - zinc salts, 393, 394, 772
  - copper sulphate (corneal), 397
  - alum, 402
  - acacia, 426
  - benzoin, 482
  - copaiba, 486
  - acetanilide, 497
  - terebene, 525
  - storax, 527
  - grindelia, 531
  - myrrh, 585
  - bismuth, 589
  - naphthalene (venereal), 624
  - salicylic acid, 630
  - cocaine, 657
  - holocaine (corneal), 662
  - orthoform, 663
  - alcohol, 722
  - hydrated chloral, 752
  - chloretone, 757
  - chloroform (rectal), 772
  - hydrastis (venereal), 798
  - hydrastine, 799
  - ichthyol, 839
- **Ulcer, Gastric**
  - arsenic, 219
  - potassium dichromate, 318
  - lead acetate, 380
  - silver salts, 388, 389, 390, 737
  - opium, 389, 737
  - hyoscyamus, 389
  - Dover's powder, 520
  - bismuth, 590, 737
  - orthoform, 664
  - atropine, 701
  - zinc salts, 701, 737
  - chloroform, 772
  - nutrient serum, 814
- U'lmus, 425
- **Uncinariasis**
  - thymol, 97
  - aspidium, 102
  - betanaphthol, 624
- Ungue'ntum metallo'rum, 394
- **Uræmia**
  - magnesium sulphate, 194
  - pilocarpine, 445
  - hot baths, 462
  - enteroclysis, 463
  - croton oil, 618
  - morphine, 742, 743
- Urea formation, drugs modifying, 553
- Urethane, 762
- Urethra, drugs acting on, 458
- **Urethritis.** *See* Gonorrhœa.
- **Uric Acid Diathesis** (Uricacidæmia)
  - potassium bicarbonate, 145
  - lithium salts, 189
  - magnesium sulphate, 193

- **Uric Acid Diathesis**
  - piperazine, 471
  - urotropin, 479
  - salicylates, 631
- Urinary system, drugs acting on, 452
  - antiseptics, 456
  - sedatives, 458
- Urine, composition altered, 457
  - decomposition prevented, 456, 478
  - increased, 452
  - diminished, 455
  - rendered acid, 455
    - alkaline, 455
- **Urine, Incontinence of**
  - oil of turpentine, 325
  - krameria, 368
  - collodion, 410
  - uva ursi, 467
  - cantharides, 476
  - benzoates, 483
  - cubeb, 487
  - strychnine, 672
  - belladonna, 702
  - hydrated chloral, 753
  - ergot, 796
- Urotropin, 478
- **Urticaria**
  - black wash, 31
  - yellow wash, 31
  - phenol, 58
  - arsenic, 222
  - lead subacetate, 379
  - creosote, 432
  - glycerin, 432
  - oil of peppermint, 432
  - benzoin, 482
  - mercuric chloride, 482
  - acetanilide, 497
  - salicylic acid, 631
  - zinc oxide, 631
  - starch, 631
  - menthol, 653
  - belladonna, 699
  - boric acid, 752
  - hydrated chloral, 752
  - chloroform, 772
  - cimicifuga, 801
- Uterus, drugs acting on, 784, 791
- Uterine action, substances which depress, 784, 802
- U'va u'rsi, 466

- VAGINITIS. *See* Leucorrhœa
- Vagus centre, drugs acting on, 229, 279
- Valerates, 581
- Valerian, 581
- Vallet's mass, 200
- Vani'lla, 846
- Vanillin, 845
- **Variola.** *See* Small-pox
- **Varicocele**
  - collodion, 410
  - douching, 462
  - hydrated chloral, 752
- Vascular irritants, 297
- Vaso-motor centre, drugs acting on, 301
- Vaso-constrictors, 298
- Vaso-dilators, 297, 301
- Vegetable cathartic pills, 608
  - lancet, 280
  - mercury, 608
  - sulphur, 848
- Veratrine, 289
- Vera'trum, 288
- Vermicides, 16
- Vermifuges, 16
- Veronal, 759
- Vesicants, 297
- Vessels, drugs acting on, 296, 301
- Vibu'rnum, 802
- Vienna paste, 137
- Villacabras water, 164, 547
- Vinegar, 308
- Vi'num a'lbum, 711
  - ru'brum, 711
- Vitellin, silver, 388
- Vittell water, 195
- Vitriol, blue, 396
  - oil of, 301
  - white, 391
- Vleminckx's solution, 90
- Volatile liniment, 176
- **Vomiting**
  - gray powder, 34
  - phenol, 60
  - hydrogen dioxide, 84
  - sodium sulphite (yeasty), 89
  - charcoal (of pregnancy), 95
  - lime water, 197
  - arsenic, 219
  - camphor, 275
  - aconite (of pregnancy), 287
  - sinapisms, 353
  - oil of cajuput, 335
  - amyl nitrite (of pregnancy), 351
  - nitroglycerin, 352
  - ammonia, 356
  - spirit of nitrous ether, 356
  - glycerin (of pregnancy), 434
  - blisters, 474
  - hydrocyanic acid, 509
  - ipecac, 520
  - calumba (of pregnancy), 555
  - cinnamon, 563
  - pancreatin, 580
  - bismuth, 590
  - cerium oxalate, 591
  - cocaine (of pregnancy), 658
  - bromides, 689
  - atropine, 700
  - chloroform, 700, 772
  - belladonna, 701
  - alcohol, 722
  - morphine, 737
  - hydrated chloral, 753
  - chloretone, 757
  - iodine, 830
  - carbon disulphide, 849
- **Vulvitis**
  - phenol, 58
  - lead lotions, 379
  - zinc sulphate, 379
  - alum, 401

- WAHOO, 607
- Warburg's tincture, 131
- **Warts.** *See* Condylomata
- Wash, black, 20
  - yellow, 20

Water, 458
  distilled, 458
Waukesha water, 195
Wax, 847
Weld's syrup of ferric chloride, 204
Whiskey, 711
White corpuscles, drugs acting on, 136
  mustard, 331
  oak, 357
  petrolatum, 408
  precipitate, 18
  vitriol, 891
  wax, 847
  wine, 711
Whooping-cough. *See* Pertussis.
Wildungen water, 195
Wine, red, 711
  white, 711
Wintergreen, oil of, 632
Witchhazel, 371
Wool-fat, 406
Worms, Round
  santonin, 108
  spigelia, 109
  chenopodium, 110
Worms, Seat
  sodium chloride, 171
  lime water, 197
  tincture of ferric chloride, 208
  camphor, 277
  turpentine, 323
  tannic acid, 362
  calumba, 555
  quassia, 557
  aloes, 600
Worms, Tape
  aspidium, 102
  kamala, 103
  kusso, 103
  pomegranate, 105
  pelletierine tannate, 105
  pumpkin seed, 106
  oil of turpentine, 323
  eucalyptus, 338
  olive oil, 415
  slippery elm, 425
  chloroform, 773
  croton oil, 773
  petroleum benzin, 849
Wormseed, American, 110
  Levant, 106
Wounds
  phenol, 57, 59, 360
  formaldehyde, 48
  iodoform, 69
  boric acid, 76
  boroglycerin, 77
  potassium permanganate, 80
  hydrogen dioxide, 83
  balsam of Peru, 100, 597
  potassium chlorate, 157
  veratrum, 293
  oil of turpentine, 322
  tar, 328
  rosin cerate, 330, 486
  eucalyptus, 337
  tannic acid, 360
  witchhazel, 372
  rhus glabra, 373
  adhesive plaster, 374
  silver, 386
  zinc chloride, 393
  collodion, 410
  benzoin, 482
  acetanilide, 497
  terebene, 525
  bismuth, 589
  castor oil, 597
  naphthalene, 624
  calomel, 624
  opium, 738
  hydrated chloral, 752
  calendula, 841
Wounds, Infected. *See also* above.
  sulphurous acid, 93
  hydrochloric acid, 307
  nitric acid, 307
  chloretone, 757
Wourara, 646

XANTHOXYLUM, 838
  Xeroform, 587

YELLOW FEVER
  oil of turpentine, 324
Yellow Jasmine, 680
  mercuric oxide, 19
    subsulphate, 19
  mercurous iodide, 19
  potassium prussiate, 506
  wash, 20
  wax, 847
Ye'rba Sa'nta, 531

ZE'A, 471
  Zinc salts, 391
Zi'nci bro'midum, 683
  io'didum, 832
  phenolsu'lphonas, 65
  pho'sphidum, 916
  va'leras, 581
Zi'ncum, 391
Zi'ngiber, 576

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